US Army Corps
of Engineers
Kansas City District

Engineering and Construction Division
Hydrologic Engineering Branch
Water Management Section

# Annual Report of Reservoir Regulation Activities

## Summary for 2001 - 2002

March 2003

**NORTHWESTERN DIVISION, KANSAS CITY DISTRICT**
**SUMMARY OF LAKE REGULATION ACTIVITIES**
**AUGUST 1, 2001 TO JULY 31, 2002**

## PURPOSE AND SCOPE.

This report summarizes the past year's regulation activities at lake and reservoir storage projects within the boundaries of the Kansas City District (District) that are operated for flood control by the Water Management Section staff. It also summarizes major work items affecting the projects, and it outlines briefly the programs ongoing or proposed for the year ahead. Topics discussed in the report include climatology, project accomplishments, current project operations; major regulation problems and proposed solutions; lake regulation manuals; data collection programs and procedures; ongoing studies, and personnel of the Water Management Section. The reporting period for Water Management Section activities covers the operating year from August 1, 2001 through July 31, 2002, with additional discussion on proposed operations and studies programmed through fiscal year 2003. The reporting period for certain items reported by other District elements may cover the fiscal year or calendar year, depending on the reporting requirements specified by their applicable regulations. Preparation of this report is in conformance with paragraph 13b of ER 1110-2-240, dated October 8, 1982.

## LAKES IN THE KANSAS CITY DISTRICT.

The Kansas City District encompasses the watershed of the Missouri River from Rulo, Nebraska, (mile 498.1 above the mouth) to the junction of the Missouri and Mississippi Rivers near St. Louis, Missouri. During the period covered by this report, 29 storage projects at which the Corps of Engineers (Corps) has either complete or partial water control responsibilities were in operation within the District. The location of each lake and reservoir in the District is shown on Plate 1, and a summary of engineering data outlining the physical characteristics of each project is included as Plates 2A through 2E.

## PROJECT FUNCTIONS AND GENERAL PLAN.

Functions served by storage facilities in the Kansas City District include: flood control, irrigation, water supply, low flow and navigation supplementation, water quality, hydroelectric power, recreation, and fish and wildlife. All functions but flood control are normally provided through the regulation of storage contained in the multipurpose pool. Hydropower is generated during releases from both flood control and multipurpose storage. The general plan for regulation of flood control storage is to evacuate all accumulations in the flood control space as rapidly as downstream channel capacities and flow conditions permit. Should the top of the flood pool be exceeded, criteria have been developed for each project that schedule releases with an aim toward safeguarding the structure. Downstream interests are warned of the possibility of flooding should a surcharge operation appear likely. Releases from multipurpose and flood control storage are regulated mainly by the manipulation of gates or other means in accordance with plans, schedules, and rule curves prepared in advance to meet various conditions of inflow, water demand, and downstream channel conditions. Releases from surcharge storage at most of the projects are through uncontrolled spillways, although a few of the larger projects have tainter gates installed in the spillways. Although the storage space in the flood control pool is normally evacuated as quickly as downstream conditions allow, release schedules may be modified at times to serve other uses such as fish and wildlife enhancement and navigation flow supplementation when stored water occupies only the lower portion of the flood control pool.

## CLIMATOLOGY AND HYDROLOGIC CONDITIONS.

The year 2001 began with variable but relatively normal conditions for both precipitation and temperatures. February, late May, and June were unusually wet over central and eastern portions of the District. In June, record flooding occurred on the South Grand River near Urich, Missouri, and on Stranger Creek at Easton, Kansas. However, for the reporting year through July 2001, flooding events were infrequent, and inflows to District reservoirs reached only 80 percent of normal. Dry conditions were more prevalent in the western portions of the District, where irrigation water is vital to farming.

The second half of 2001 continued the trend of variable weather, with mild and generally drying conditions. September was the only month with above average rainfall and stream flows, and that was limited to central and eastern Kansas into Nebraska and northwest Missouri. October was mostly cool and dry, except for normal rainfall in Missouri with some minor flooding during the middle of the month. November and December closed out the year with much above normal temperatures and dry conditions, in contrast to the very cold December conditions one year earlier. November 2001 was the warmest November on record for the Midwest. Abnormally dry conditions as measured by the NCDC Drought Monitor spread from Texas into the southern half of Kansas and into central Missouri, although drought was not a concern to central and eastern portions of the District during the calendar year 2001.

For the calendar year 2001, the National Climatic Data Center reported that temperatures and precipitation over the District were a little above normal, with the driest conditions being in western Kansas and the wettest conditions being in northwestern Missouri. Kansas City experienced its third wettest year on record, although as noted earlier rainstorms resulting in major flooding were rare. Calendar year inflows to District lake projects improved to 93 percent of normal, with above normal inflows to lakes in central and eastern Kansas. The Osage River basin was drier than normal. The driest portion of the District remained in the far west. Although soil moisture conditions in the far west closed the year only moderately dry, hydrologic drought continued into its second year with many Bureau of Reclamation irrigation reservoir levels continuing to fall.

For the Missouri River Basin as a whole, the Corps Reservoir Control Center reported that the calendar year runoff above Sioux City was 22.5 MAF in 2001, or 89 percent of normal. Much better than normal spring runoff from the plains states partially made up for a lack of snow in the mountains. However, there was no year-to-year recovery in the pool storage at the main stem dams. Releases from the dams provided a full-length navigation season, but the support level was set at 3,000 cfs below full service. This was equivalent to 38,000 cfs at Kansas City.

January and February 2002 continued the trend of above normal temperatures and generally dry conditions, except for one mostly beneficial storm at the end of January. In Kansas the storm produced snow. But from the Kansas - Missouri border eastward the storm produced mostly ice. In Kansas City, it was considered the worst ice storm in its history, with power out to large portions of the metropolitan area for many days. March was marked by a very cold start, with temperatures near zero. Above normal temperatures returned in April, but so did the spring rains, greatly improving stream flows for all but the western third of the District.

May was a month of contrasts, with a series of very wet storms in Missouri producing a peak flow of 345,000 cfs for the Missouri River at Hermann. Much of the flow came in from tributaries downstream of Kansas City, especially the Grand, Chariton, and other uncontrolled

streams. Long Branch, Stockton, Pomme de Terre Lakes received over 400 percent of their normal inflow during the month, and all rose into their Phase II flood pools. Long Branch reached a record high pool elevation at 802.74. It was the third wettest May on record in Missouri. In contrast, precipitation was just a little above normal in the lower Kansas River basin, and it continued below normal in western Kansas.

June and July closed the 2002 reporting period with normal to hot temperatures and a return to dry conditions through most of the District, especially from north central Kansas northward into Nebraska. For the reporting period August 2001 through July 2002, only Missouri suffered any major flooding and that was limited to May 2002. Thanks to April and May 2002, precipitation for the reporting year was close to normal in Missouri. But it was a little below normal in Iowa and among the 10 driest years on record (107 years) in northern Kansas and Nebraska. It was the driest period on record in Colorado, contributing to a very severe summer fire season in the intermountain west. Although streamflows had improved in 2001 and again in May of 2002, for the entire period this was the third reporting year of below normal streamflows averaged across the District, with streamflows just 73 percent of normal. Temperatures for the reporting year were among the 10 warmest on record.

During the second half of the calendar year 2002 the drought returned with a vengeance, spreading from the western portions of Kansas and Nebraska and eventually encompassing all but the lowest portion of the Missouri River basin around St. Louis upstream to Hermann. The summer was hot and dry. Temperatures were normal or above normal in every month except October. Precipitation was above normal in only two months, August and October, and this was limited mainly to central Missouri. In central and western Kansas on into Nebraska many smaller streams stopped running altogether. The Platte River in central Nebraska stopped flowing in early August for the first time in 20 years. Extreme drought conditions built into both northwestern Missouri and throughout Nebraska. During the period June through December, Kansas City only received 40 percent of its normal precipitation, a deficit of over 14 inches. This was in contrast to 2001, when northwestern Missouri was the wettest area in the District. Western Kansas received some beneficial rains in October reducing their agricultural drought conditions from extreme to moderate, but the rains did little to improve hydrologic streamflows.

Summary reports from the National Climatic Data Center showed that calendar year 2002 was generally warmer and drier than normal across the District, with the driest conditions existing from northwestern Missouri through the northern Kansas River basin on into Nebraska and Colorado. In Kansas City, it was the 7$^{th}$ driest year on record and the driest since the drought of 1988. A 41-day stretch without rain from mid-November through late December was the longest on record. It was the driest calendar year on record for Colorado. Streamflow for the calendar year was 62 percent of normal averaged across the District with the best conditions in Missouri. Reservoir inflow at lakes in the Kansas River basin was only 31 percent of normal. El Nino conditions had been building in the Pacific during the year, peaking in December.

For the Missouri River Basin as a whole, the Corps Reservoir Control Center reported that the calendar year runoff above Sioux City was just 16.0 MAF in 2002, or 64 percent of normal. This was the 10$^{th}$ lowest runoff in 105 years of record keeping and the third consecutive year of below normal streamflows. Releases from the mainstem dams provided a full-length navigation season, but the support level was set at minimum service or 6,000 cfs below full service flows. This was equivalent to 35,000 cfs at Kansas City.

## PROJECT ACCOMPLISHMENTS.

Operating purposes at storage projects in the Kansas City District include flood control, irrigation, water supply, low flow and navigation supplementation, water quality, hydroelectric power, recreation, and fish and wildlife. Project accomplishments in each of these functional areas, for the period covered by this report, are described briefly in the following subparagraphs.

### *Flood Control.*

Stream flow regulation by storage projects in the Kansas City District began with the closure of Kanopolis Lake in February 1948. By July of that year, Kanopolis also provided the first flood control storage, benefiting downstream damage centers. Since this initial impoundment, stream flow regulation by District projects has produced flood reduction benefits estimated in the millions of dollars annually. In addition to the Corps lake projects, local protection projects in the form of levees, floodwalls, and channel improvements also have provided flood reduction benefits amounting to millions of dollars. Federal and private agricultural levees along with temporary storage of flood flows in the main stem reservoir system above Sioux City provide additional benefits within the District.

**Table 1: Flood Reduction Benefits**
**October 1, 2001 through September 30, 2002**

| Project | Fiscal Year 2002 | Cumulative |
|---|---|---|
| **Clinton Lake, KS** | $108,000 | $813,110,000 |
| **Harlan County Lake, NE** | $50,000 | $150,064,000 |
| **Harry S Truman Resv., MO** | $2,257,000 | $1,840,235,000 |
| **Hillsdale Lake, KS** | $466,000 | $31,215,000 |
| **Kanopolis Lake, KS** | $31,000 | $1,159,728,000 |
| **Little Blue River Lakes, MO** | $0 | $50,813,000 |
| **Long Branch Lake, MO** | $3,073,000 | $48,156,000 |
| **Melvern Lake, KS** | $1,151,000 | $149,383,000 |
| **Milford Lake, KS** | $122,000 | $940,046,000 |
| **Perry Lake, KS** | $344,000 | $4,164,578,000 |
| **Pomme De Terre Lake, MO** | $432,000 | $66,075,000 |
| **Pomona Lake, KS** | $765,000 | $152,802,000 |
| **Rathbun Lake, IA** | $2,393,000 | $144,681,000 |
| **Smithville Lake, MO** | $3,300,000 | $517,938,000 |
| **Stockton Lake, MO** | $673,000 | $201,112,000 |
| **Tuttle Creek Lake, KS** | $2,205,000 | $3,949,013,000 |
| **Wilson Lake, KS** | $483,000 | $1,373,422,000 |
| **TOTALS** | **$17,853,000** | **$15,752,371,000** |
| Oct 1, 2000, to Sep 30, 2001 | $319,697,000 | $15,734,518,000 |
| 10-Year Average (1993-02) | $1,384,204,200 | |

For the reporting period August 2001 through the end of 2002, there were only scattered reports of minor flooding due to spring, summer, and early fall convective activity. Widespread minor to moderate flooding occurred in the lower Kansas River basin in September 2001. Moderate to major flooding was limited to north central Missouri following a series of rainstorms in May 2002. Almost all of the flooding activity during the May event was downstream of Kansas City. On the Missouri River at Hermann, the peak flow reached 345,000 cfs on May 14, 2002. Long Branch, Stockton, and Pomme de Terre Lakes received over 400 percent of their normal inflow during the month, and all rose into their Phase II flood pools. Truman's inflow as a percent of normal was less, but it also rose into its Phase II flood pool as it was regulated to reduce flooding on the lower Osage and the lower Missouri Rivers. The excess flood control storage was evacuated at all lakes except Stockton by the end of June. At Stockton, the flood storage evacuation continued into August.

During the May flood event, Long Branch Lake reached a record high pool elevation of 802.74. This is 1.74 feet above the design top of the flood pool. At the top of the flood pool, the release capacity from the uncontrolled outlet increases rapidly, but this lake level did not result in

any downstream flooding. The crest elevation of the uncontrolled perched spillway is at 809.0. The project was placed on critical surveillance, but no safety concerns were encountered.

The evacuation of the excess Truman flood control storage in May was complicated by two factors. Releases from the lake had to be adjusted not only to reduce flooding on the lower Osage River and the lower Missouri River but also so as not to increase flooding on the Mississippi River. Major flooding was occurring at the time in the middle Mississippi River downstream of St. Louis. Therefore, the Omaha Reservoir Control Center coordinated with St. Louis District to ensure that Truman releases did not add to flooding on the Mississippi River. Bagnell Dam also suffered a major fish kill during this period, and Truman releases were adjusted to improve the conditions identified by Missouri Department of Conservation as contributing to the fish kill. This deviation from normal operations was approved by the Reservoir Control Center. Additional details are provided later in the report in the section on Fish and Wildlife Operations.

Flood reduction benefits during Fiscal Year 2002 (October 1, 2001, through September 30, 2002) credited to all Corps lake projects in the District were $17, 853,000. This total is only a small fraction of the long-term average, reflective of the worsening drought conditions. Table 1 lists the flood reduction benefits credited to the Corps lake projects in the District. When the additional benefits from levees, the main stem reservoirs, and the regulation of flood control storage in the Bureau of Reclamation lake projects in the District are included, flood reduction benefits in the District totaled $21,655,000.

***Irrigation.***

Carryover storage at Bureau of Reclamation lake projects and Harlan County Lake (Corps of Engineers) was below average at the end of the 2000 irrigation season with the exception of Keith Sebelius Lake (Norton Dam) and Kirwin, Webster, and Cedar Bluff Reservoirs. Precipitation at the project dams during 2001 ranged from 87 percent of normal at Enders Dam to 122 percent of normal at Lovewell and Harlan County Dams. Unfortunately, there were few runoff-producing storms, particularly in the drought regions of the upper Republican River basin. The calendar year 2001 inflow was below the dry year forecast at Bonny and Enders Reservoirs and at Swanson and Hugh Butler Lakes. Harlan County, and Harry Strunk Lakes had inflows between the dry- and normal-year forecasts. Keith Sebelius Lake and Waconda Lakes, along with Kirwin, Webster, and Cedar Bluff Reservoirs had inflows between the normal and wet year forecasts. None of the lakes had inflows above the wet year forecasts.

At the beginning of the 2001 irrigation season in June, Enders Reservoir and Keith Sebelius, Swanson, and Hugh Butler Lakes did not have sufficient storage to provide water users with a full water supply. Three lakes, Lovell, Harry Strunk, and Waconda, filled slightly into their flood pools during the spring, requiring small flood control releases. Harlan County Lake filled to the top of its irrigation pool at the beginning of the season, but no flood releases were needed. Cedar Bluff hovered around full pool and filled slightly into the flood pool in early September 2001, but again no flood control releases were required.

Hot and generally dry conditions in July and August 2001 led to high irrigation demands that significantly reduced storage in most reservoirs. Carryover storage at the end of the 2001 irrigation season again was below normal at most projects, with the exception of Keith Sebelius and Waconda Lakes, and Kirwin, Webster, and Cedar Bluff Reservoirs. Total carryover storage

at the irrigation projects was 921,000 acre-feet (AF) at the end of September 2001, compared to 855,000 AF at the end of September 2000.

During calendar year 2001, the latest period for which final figures are available, the eleven Reclamation reservoirs in the Kansas River basin, plus the Corp's Harlan County Lake, provided 233,579 AF of irrigation water to 148,968 acres of project lands, reflecting a lower than normal storage at the beginning of the irrigation season in the upper Republican River basin. This compares to 305,189 AF of irrigation water provided to 151,857 acres during calendar year 2000. Favorable weather earlier in the growing season led to slightly higher than normal crop yields in 2001 compared to 2000. The average corn yield, the principal drop of all reporting districts, was 160 bushels per acre, up from 140 bushels per acre in 2000.

The State of Colorado makes Bonny Reservoir storage water available to Hale Ditch and other natural flow appropriators under short-term water service contracts. Most of the 700 acres served by Hale Ditch are now owned and operated by the Colorado Department of Natural Resources, Division of Wildlife. During 2001, at the request of the State of Colorado, 2,075 AF of water were diverted to Hale Ditch.

Inflows during the winter of 2001 and the spring of 2002 generally continued below normal. At the beginning of the 2002 irrigation season, only Harry Strunk and Lovewell had refilled. Minor flood control releases were needed from each of the lakes, but they were accomplished in conjunction with irrigation releases at the beginning of June. Details on the 2002 irrigation season will not be available until the next Annual Report.

***Municipal and Industrial Water Supply, and Water Quality Enhancement.***

Water supply contracts for lake storage space, annual withdrawals, or surplus water exist between the Corps of Engineers and the State of Kansas and 12 other municipalities and rural water districts within Kansas, Missouri, and Iowa. The State of Kansas in turn contracts with a large number of municipalities and industrial sites to supply water from the State's contracted storage space through the water assurance and water marketing programs. To date, assurance districts have been formed for users in the lower Kansas River and the State of Kansas portion of the Marais des Cygnes River. The State of Kansas is now working to form a new assurance district in the Smoky Hill River basin using recently contracted water from Kanopolis Lake. Water is supplied within the limits of each contract through requested lake releases to downstream users or from privately owned intakes located on the lake. The following projects currently have active water supply contracts: Kanopolis, Milford, Tuttle Creek, Perry, Clinton, Melvern, Pomona, Hillsdale, Smithville, Longview, Rathbun, Long Branch, Stockton, and Harry S. Truman. Most of the municipalities and rural water districts holding contracts with the Corps utilize the available water annually.

For the second reporting year in a row, the State of Kansas called for releases from its contracted water supply storage at Milford, Tuttle Creek, and Perry Lakes. The Kansas Water Office requested additional releases of 52 cfs from Milford Lake for a downstream water marketing contract holder during the period November 9 through December 31, 2001. Releases from State water assurance storage in Corps reservoirs were not necessary to support lower Kansas River flows during the fall and winter of 2001-02. With drought conditions returning in 2002, additional releases from the Kansas lakes were again needed after the completion of the summer 2002 flow supplementation for Missouri River navigation. Beginning July 17, 2002,

releases from Milford Lake were needed to help meet the water quality / water supply flow targets at Topeka and DeSoto. Releases from Tuttle Creek and Perry were gradually added to the Milford releases, and they continued intermittently through the summer, fall, and winter of 2002-03. For about three weeks in November 2002, the releases were used to meet navigation flow supplementation targets for the Missouri River. During such periods, the lake releases are not credited against the water quality / water supply storage contracts.

Melvern and Pomona Lakes provide water for the Marais des Cygnes Assurance District. Similar to the Kansas River Water Assurance District, releases were made from the Marais des Cygnes District storage for the first time during the 2000-01 reporting period. Releases from Melvern and Pomona water assurance storage were not needed during the 2001-02 reporting period. They were resumed during the winter of 2002 03.

Kansas City District completed a reallocation of 12,500 AF of multipurpose storage space (after adjustment for future sedimentation) in Kanopolis Lake during 2001. After the reallocation was approved by USACE, the District signed a contract dated June 2002 with the State of Kansas for the storage space. The State plans to either contract the water to individual municipalities and/or form an assurance district with interested water users.

Three municipalities and one rural water district have executed water service contracts for full or supplemental water supplies from three Reclamation reservoirs. A contract with the City of Norton, Kansas, provides for a maximum annual usage of 1,600 AF from Keith Sebelius Lake (Norton Dam). A contract with the City of Beloit, Kansas, provides for a maximum annual usage of 2,000 AF from Waconda Lake. Waconda Lake also provides up to 1,009 AF of water for a contract with the Mitchell County Rural Water District No. 2. A contract with the City of Russell, Kansas, provides for a maximum annual usage of 2,000 AF from Cedar Bluff Reservoir.

During the calendar year 2001, the City of Norton used 559 AF of municipal water from Keith Sebelius Lake. No storage releases were made from Waconda Lake for the City of Beloit, but the Mitchell County Rural Water District used 739 AF. At the direction of the Kansas State Water Commissioner, Reclamation bypassed 8,447 AF from Waconda Lake for water quality control. No releases were made from Cedar Bluff Reservoir for the City of Russell. The State of Kansas used the fish hatchery below Cedar Bluff Dam for nurturing waterfowl. Approximately 360 AF of water were released from Cedar Bluff Reservoir in 2001 for use at the fish hatchery.

The Corps Reservoir Control Center in Omaha is responsible for regulating the Missouri River main stem reservoirs to provide minimum flows on the Missouri River needed for municipal and industrial water supply intakes and water quality enhancement. Many years ago, winter releases necessary to maintain minimum flows of about 6,000 cfs at Kansas City were considered sufficient for both water quality and water supply purposes. However, much of the Missouri River channel has degraded during the intervening high flow years, resulting in river stages that are now lower than they used to be for a given river flow. River flows considered sufficient 40 years ago would now result in operational problems at many water intakes along the river. The Corps believes it is primarily the responsibility of the intake owners to make adjustments to their intakes as channel conditions change. When water is available, the Reservoir Control Center now attempts to regulate Gavins Point Dam releases to maintain a minimum downstream flow of 13,000 cfs during the winter to reduce the impacts of the river channel degradation. During dry winters this results in a Missouri River flow of 18,000 cfs to

22,000 cfs at Kansas City. Gavins Point releases may be increased at times during the winter to manage icing problems in the river reach from Gavins Point to Kansas City.

Recommendations for minimum stream flows to benefit stream sanitation and for the maintenance of desirable water quality standards were originally established by the U.S. Public Health Service for river reaches below authorized Federal dams in the District. These recommendations were then utilized to establish minimum release requirements from the lakes after they were constructed. The minimum release standards set by the Corps water control plans are usually less than the minimum desirable stream flows set by state water authorities. The latter are intended to satisfy water right holders and fish and wildlife flow standards. In some cases, specific water quality storage allocations were included in the project planning to increase the reliability of the minimum flow releases. Depending on the lake project, the minimum release quantities may be constant through the year, or they may vary seasonally or vary depending on the amount of current lake storage. Minimum releases for the purposes of downstream quality control and stream sanitation range from 3 cfs during the winter months at Hillsdale Lake to 100 cfs at Tuttle Creek Lake. Large minimum flow releases during certain seasons are also included in the water level management plan for Pomme de Terre Lake and in an agreement with the State of Missouri at Harry S. Truman Reservoir. Project releases may be reduced below minimum requirements for brief periods due to construction, periodic inspections, or emergencies. Seepage is generally considered sufficient to meet minimum flow requirements downstream at most Reclamation dams.

***Navigation.***

Releases from the Missouri River main stem reservoir system are designed to provide equitable service to navigation and other project purposes, while at the same time recognizing the important flood control functions of the system. Navigation on the Missouri is limited to the ice-free season, with a full season normally extending from April 1 to December 1 at the mouth. Operating experience plus numerous studies have indicated that flows of 35,000 cfs at Kansas City are the minimum that will permit economical navigation. Groundings can occur with flows of that magnitude, and dredging may be needed to alleviate local problems. Therefore, an additional flow of 6,000 cfs above the minimum service target has been set as the "full service" level for the navigation function. Thus, a full-service target flow of 41,000 cfs at Kansas City is considered adequate to maintain the designed 9-foot by 300-foot channel with no dredging.

In normal times, power releases from Gavins Point Dam on the Missouri River above Omaha, plus local inflows between Gavins Point and Kansas City, keep navigation flows at the full service level through the reach from Kansas City to the mouth. In years of excess water supply, releases greater than those needed to maintain full service navigation flows are made from the main stem reservoirs to evacuate flood control storage accumulated in the spring and early summer. When an abundance of water is available, the season can be extended an additional 10 days at the end of the season, ice conditions permitting. The decision to extend the season is based on both main stem reservoir system storage and forecast annual basin runoff, the guidelines for which are described in the Missouri River Basin Master Manual.

Drought conditions became established throughout the Missouri River basin in 2000, with the runoff above Sioux City at just 16.5 MAF, or 65 percent of the normal 25.2 MAF. The Corps Reservoir Control Center in Omaha maintained a full-length navigation season, but flow

support was reduced to 1,500 cfs below the full support level, equivalent to a minimum flow of 39,500 cfs at Kansas City.

For the calendar year 2001, much better than normal spring runoff from the plains states partially made up for a lack of snow in the mountains. However, there was no year-to-year recovery in the pool storage at the main stem dams. The calendar year 2001 Missouri River runoff was 22.5 MAF above Sioux City, 89 percent of the normal 25.2 MAF. Releases from the dams provided a full-length navigation season, but the support level was set at 3,000 cfs below full service, equivalent to a target flow of 38,000 cfs at Kansas City.

Although the winter and spring of 2001-02 provided relatively normal precipitation in the Kansas City District, drought conditions continued in the upstream Missouri River basin. A poor mountain snowpack and virtually no plains runoff resulted in a repeat of the 2000 drought year. The calendar year 2002 runoff for the Missouri River above Sioux City was just 16.0 MAF, or 64 percent of normal and the 10$^{th}$ lowest runoff in 105 years of record keeping. The Reservoir Control Center again was able to maintain a full-length season, but flow support was further reduced to minimum service, equivalent to a target flow of 35,000 cfs at Kansas City.

The 2002 navigation season was partially disrupted by a midseason U.S. Fish and Wildlife Service ruling that Tern and Plover nests located on low lying sand bars along the Missouri River could not be moved. The Terns and Plovers are listed species protected under the Endangered Species Act. In past years, the Corps had removed low-lying nests as water releases from Gavins Point Dam were increased during the navigation season. In drought years, Gavins Point releases must be increased to meet the downstream flow targets, making up for decreasing discharges from tributaries like the Platte River. The eggs from removed nests are incubated in a special rearing facility constructed for that purpose. The success of the rearing facility is not always as good as natural conditions, but the required fledge ratios at remaining nests have been met in recent years in any case. This year, the Corps was required to restrict mainstem dam releases until late August when the young chicks matured sufficiently to be able to avoid rising waters resulting from increased releases from Gavins Point Dam.

As a result of the USFWS ruling, the Corps was unable to make a planned Gavins Point increase in late June 2002. By supplementing Missouri River flow with releases from Kansas River lakes, the Corps provided minimal navigation support through mid-July on the lower Missouri River. But eventually the water available from the Kansas lakes was used up, and river flows at Kansas City fell to 7,000 cfs below the flow target for a period of about a month from mid-July through mid-August 2002. Although smaller towboats and light-loaded barges were able to continue operating, spokesmen for the barging industry and the State of Missouri claimed that the missed targets resulted in an economic loss of $7,000,000 to the industry.

Releases for navigation supplementation from Kansas River basin lakes are not required when basin runoff is normal or higher than normal, as it was through most of the 1990's. However, during years of below normal water supply, Kansas lakes may be called upon to supplement Missouri River flows below Kansas City in order to meet the navigation flow requirements as part of the Missouri River project system operations and to conserve water in the upstream main stem lakes. The decision to make supplementation releases usually occurs when the local natural inflow from Nebraska City to Kansas City (including the Kansas River) is less than 4,000 cfs. Guidelines for navigation supplementation releases are contained in existing project and basin water control manuals. The manuals allow additional releases from Milford,

Tuttle Creek, and Perry Lakes of up to the deficit in inflows between Nebraska City and Kansas City, as requested by the Reservoir Control Center. The volume of water available from the three lakes is limited to a drawdown of three feet from multipurpose pool levels before October and another three feet after October, after allowance for any water supply releases.

With the dry upper basin conditions in 2001, the Reservoir Control Center requested that the District provide supplemental releases from the Kansas River lakes to maintain a target flow of 2,000 cfs at DeSoto beginning in early September 2001. At that time Milford, Tuttle Creek, and Perry Lakes all had flood control storage in addition to multipurpose storage available for supplemental releases. Although Kansas River flows were less than normal, inflows from uncontrolled tributaries to the Kansas River were usually high enough that the supplemental flows provided from Milford, Tuttle Creek, and Perry Lakes were taken entirely from flood control storage. No supplemental releases were taken from multipurpose storage in 2001.

But the year 2002 was dry in the Kansas River basin as well. As noted on the previous page, the Corps Reservoir Control Center requested that Kansas City District provide supplemental releases beginning in July 2002. At that time all of the lakes had been drawn down to their multipurpose level. Supplemental releases from multipurpose storage was initially provided by Milford and Tuttle Creek Lakes on July 2, 2002, with Perry Lake releases beginning on the next day. The DeSoto flow target was initially set at 3,500 cfs, and it was gradually decreased to the water quality / water supply target of 1,000 cfs at the end of the supplementation period. The flow supplementation releases continued from each lake until they were each drawn down the maximum of 3 feet from the top of the multipurpose pool level. Navigation releases were terminated at Perry Lake on July 10, at Milford Lake on July 17, and at Tuttle Creek Lake on July 18. Additional supplemental water is usually available after October 1, when the lakes can be drawn down another 3 feet. But in 2002, a significant volume of multipurpose storage in each of the lakes had been used in the intervening period to meet the water quality / water supply flow targets at Topeka and DeSoto. The Reservoir Control Center requested additional supplemental releases from each of the lakes beginning November 4 and continuing through November 24, 2002. However, the target flow was set at a maximum of 1,600 cfs to ensure that the remaining available storage would last through the supplementation period. During this period, only Perry and Tuttle Creek Lakes provided navigation flow supplementation. Water quality and water supply releases continued through the winter after the navigation season, resulting in additional drawdowns at each of the three lakes.

***Hydropower.***

Hydropower can be generated at two Kansas City District projects. Harry S. Truman Dam has six units with a rated capacity of 160 megawatts, and a maximum peaking generation rate of 180 megawatts. Due to downstream channel capacity limitations only about four units with a capacity of 120 megawatts are normally operated for extended periods. Releases scheduled for the Truman hydroelectric plant anticipate peaking power generation primarily during the months of June through September, with additional generation at other times of the year as water is available and there is a need. Stockton Dam has a single unit rated at 45.2 megawatts. Normal operation of the Stockton hydroelectric facility consists of peaking power generation at a rate of 40 to 45 megawatts for a period of 6 to 10 hours daily throughout the workweek. Continuous power operation at Stockton is restricted by downstream channel capacities that limit tailwater elevations to 777.0 feet and Highway "J" stages to a maximum

reading of 17.5 feet. Power from Stockton and Truman is marketed by the Southwestern Power Administration (SWPA), and their dispatchers schedule power releases from the dams in accordance with guidelines in the water control manuals and within flood control requirements set by the Water Management Section.

The Stockton unit was available for full service in all months of this reporting period. Prior to March 1, 2001, power from Stockton was scheduled by Associated Electric Cooperative, Inc. (AECI) under contract from SWPA. That contract was terminated on February 28, 2001, after which the project returned to being part of Southwestern's interconnected system. AECI continued to contract for power delivered through SWPA, so the change has had little impact on system resources and loads. Generation by the Stockton plant during this reporting period August 2001 to July 2002 totaled 58,184 megawatt-hours, or 96 percent of average.

At the Truman power plant, five of the six units are normally available for power generation. Annual maintenance and unscheduled outages often result in one or more units out of service at any one time. During this reporting period, units 2 and 5 were taken offline for extended periods for maintenance. A thrust bearing was replaced on unit 5 during an outage lasting from March 2001 through February 2002. Unit 2 underwent periodic maintenance and repair of a head gate during the period February to May 2002. Unit 6 began a periodic maintenance cycle in November 2002. A Memorandum of Agreement between Ameren/UE, operators of Lake of the Ozarks, and the Corps was approved in June 1995, incorporating provisions stipulated in an Interim Operating Plan approved in October 1989. The Interim Operating Plan was signed between the State of Missouri, SWPA, and the Corps to mitigate the loss of pumped storage generation. The MOU and Interim Operating Plan (also called the Consensus Plan) restrict power generation to four units during the week and three units on weekends and holidays. During the period December through February, five units may be operated during the weekdays (total time limited to 600 hours per year) and three units on weekends. The tailwater elevation measured at the Highway 7 Bridge at Warsaw is limited to a maximum of 662.5 feet, Union Electric datum, during five-unit releases from the power pool. In a power emergency, SWPA may call for the full capacity of the project. At no time will power releases for power generation exceed an elevation of 664.0 feet at the Highway 7 Bridge at Warsaw. When the Truman pool elevation is above 710 feet, a minimum of one unit is operated continuously. When the pool elevation is between 706 and 710 feet, a minimum of one half unit is operated continuously during the downstream fish spawning season March through May. When the pool is below 706 feet, SWPA is only obliged to pass inflows resulting from upstream lake releases during the fish spawning season. Generation by the Truman plant during this reporting period August 2001 to July 2002 totaled 284,301 megawatt-hours, or 81 percent of average.

Inflows to Truman and Stockton Lakes improved slightly to 84 percent of normal for the current reporting period ending July 2002, compared to 71 percent of normal for the previous reporting period. Total generation at Truman and Stockton for this reporting period improved to 83 percent of the long-term average compared to 63 percent for the previous reporting period.

***Fish and Wildlife.***

Water level management plans, which include the seasonal fluctuation of pool levels for the enhancement of fish and migrating waterfowl, are proposed by the respective state resource agencies annually for most Corps of Engineers and Bureau of Reclamation projects. In Kansas

the coordinating agency is the Kansas Water Office; in Missouri the coordinating agencies are the Departments of Conservation and Natural Resources; and in Iowa the coordinating agency is the Department of Natural Resources. The proposals generally include a winter drawdown from higher fall levels to reduce ice damage along shorelines and to provide buffer space for spring rains, then a slow spring rise to enhance fish spawning, a summer level focused on recreational needs, and a higher fall level to benefit waterfowl habitat and hunter access.

When evaluating the proposals, the Water Management Section staff considers the impacts of the proposal on other project purposes including flood control, water supply, water quality, recreation, and hydropower. Water level management plans are treated as water control plan deviations, with approval required from the Northwestern Division (Division) office. During the August 2001 to July 2002 reporting period, water level management plans were approved for selected lakes in Missouri, including Smithville, Pomme de Terre, Stockton, and Long Branch, for Rathbun Lake in Iowa, and for the Corps lakes in Kansas. However, due to drought concerns the Division ordered that the winter drawdowns planned for 2001-02 not be implemented. Fluctuation plans for Reclamation lakes in Kansas were requested by the State, but they were not forwarded for approval to Division. In 2002, the State of Kansas and water management staff from Tulsa District and Kansas City District met to revise planning procedures for the annual water level management plans. The procedure will be implemented with the development of the 2003-04 fluctuation plans. The State of Missouri and Kansas City District are working toward a meeting with the 5 Corps Districts in Missouri to devise a similar plan.

Special operations required under the Endangered Species Act for Milford Lake and Tuttle Creek Lake are described in a later section on Project Operations. These are not part of the existing water control plans.

Occasionally, other agencies request modifications to District lake operations to accommodate special operations for fish and wildlife. Short-term modifications with minimal impact on other project purposes can be accommodated within the flexibility available to the District. An example is a one-unit turbine release at Truman Lake lasting for a few hours each spring. This results in ideal conditions to capture brood fish used at the State of Missouri's Lost Valley Fish Hachery. Other requested deviations can have significant impacts on other project uses and require approval by the Division office. The deviations are usually designed so that impacts to each project purpose are balanced to the maximum extent possible. In May 2002, Bagnell Dam just downstream of Truman Dam experienced a serious downstream fish kill while it was spilling water. Northwestern Division approved a water control plan deviation for Truman modifying normal flood space evacuation procedures allowing a temporary reduction in the spill at Bagnell Dam. The Truman flood control releases were then gradually increased at rates greater than normal so that the total amount of time Truman Reservoir was above a critical elevation 710.0 was about the same as with normal operations. The gradual increase in releases also allowed for a designed test of spillway releases at Bagnell Dam intended to study the effects of spill on the downstream fishery resource. The flood control targets on the lower Osage River at St. Thomas were not exceeded during this operation. The deviation was coordinated by the District with AmerenUE, the owners of Bagnell Dam, the Missouri Department of Conservation, and the lower Osage River Flood Control District.

***Recreation.***

Recreational use of the Corps lakes is a highly visible and important function. Recreational use is enhanced when the lakes are operated close to their normal or multipurpose pool levels. During flood years when large quantities of water are stored in the flood pools and during drought years when the lake levels drop, then access to the lakes and the shoreline facilities, as well as the quality of the experience, is reduced. Park managers at the projects are also concerned about related factors such as facility maintenance and water quality. The fish and wildlife function is closely related to the recreation experience, and coordination with state and county park officials for park management is important. As one would expect, projects close to metropolitan areas tend to experience the highest recreational demand.

Fiscal Year 2002 visitation figures compiled for the Corps lakes in the Kansas City District indicate an increase in visitation hours at 10 of the 18 lake projects. Although visitation increased at most lake projects close to urban centers, total visitation hours for the 18 projects decreased from the previous year. Significant decreases were noted at Stockton, Pomme de Terre, Rathbun, and Wilson Lakes. The decreases at Stockton and Pomme de Terre may have been related to unusually high lake levels early in the summer due to flood control operations. A list of the visitation totals at Corps lakes is shown in Table 2. Fee collection figures for FY 2002 had not been compiled in time for this report. Project park facilities at Blue Springs, Hillsdale, Long Branch, Longview, and Smithville are leased to county or state agencies. The fees collected at those projects are only for national passes such as the Golden Age Passport. Blue Springs Lake does not have a fee collection office.

**Table 2: Visitation and Fee Collection**
**October 1, 2001 through September 30, 2002**

| Project | Visitation (Visitor Hours) | Recreational Fees Collected |
|---|---|---|
| **Blue Springs Lake, MO** | 1,240,476 | |
| **Clinton Lake, KS** | 8,738,113 | |
| **Harlan County Lake, NE** | 8,256,726 | |
| **Harry S. Truman Resv., MO** | 9,711,889 | Not |
| **Hillsdale Lake, KS** | 2,765,279 | Available |
| **Kanopolis Lake, KS** | 1,536,528 | At This Time |
| **Long Branch Lake, MO** | 1,690,064 | |
| **Longview Lake, MO** | 2,725,487 | |
| **Melvern Lake, KS** | 5,395,415 | |
| **Milford Lake, KS** | 5,888,859 | |
| **Perry Lake, KS** | 7,624,925 | |
| **Pomme de Terre Lake, MO** | 11,178,922 | |
| **Pomona Lake, KS** | 4,124,919 | |
| **Rathbun Lake, IA** | 4,898,223 | |
| **Smithville Lake, MO** | 2,973,238 | |
| **Stockton Lake, MO** | 5,811,582 | |
| **Tuttle Creek Lake, KS** | 2,952,927 | |
| **Wilson Lake, KS** | 1,032,898 | |
| **TOTALS** | **88,546,470** | |
| **Oct 1, 2000, to Sep 30, 2001** | **93,125,464** | **$2,382,504** |
| **5-year Average (1997-2001)** | **93,382,619** | **$2,276,259** |

## PROJECT OPERATIONS.

Actual operations for the 2001-02 reporting year and the proposed operations through calendar year 2003 are discussed in the following subsections.

***Corps of Engineer Lakes - August 1, 2001 through July 31, 2002.***

With the exception of special operations required under the Endangered Species Act, Corps lakes within the Kansas City District were regulated in accordance with normal procedures during the period covered by this report. Appendix A includes pool elevation hydrographs and monthly inflow graphs at all Corps projects in the District, along with summary data providing an historical perspective.

During the past reporting period from August 2001 to July 2002, the eastern half of the District experienced warm temperatures but close to normal rainfall, following a relatively normal year for the 12 months preceding August 2001. The western third of the District was warm and dry, continuing a two-year drought. Even in Missouri there were few flooding rains, and inflow to the District lakes and reservoirs only averaged about 73 percent of normal. At the beginning of this reporting period on August 1, 2001, sixteen Corps lakes and one Reclamation lake had minor amounts of storage in their flood pools. Tuttle Creek Lake had filled about 8 percent of its available flood control space due to operations for endangered species. However, most pools lost storage during the fall, and by the end of the calendar year all of the lakes were at or below their planned seasonal pool elevations. Flood control storage was again accumulated during the relatively normal 2002 spring flood season, especially in May. But by the end of the period on July 31, 2002, most of the lakes had experienced a sufficiently long dry spell to evacuate excess flood storage, and just five Corps lakes and none of the Reclamation lakes still had some flood control storage. Flood waters still occupied about 7 percent of the Stockton Lake flood storage capacity, but that was released by the middle of August. Other lakes had accumulated minor amounts of storage mainly due to seasonal operations for water level management plans. Again, the accumulated flood control storage was mostly evacuated by the end of 2002 in accordance with normal seasonal fluctuation plans.

During the May 2002 flooding period, Long Branch Lake reached a new record high pool elevation of 802.74 on May 13, 2002. This is 1.74 feet above the nominal top of the flood control pool and 2.34 feet higher than the previous maximum pool elevation reached in 1995. The lake was placed on critical surveillance, but no problems were encountered. Since the uncontrolled spillway crest elevation is at elevation 809.0 feet and the normal outlet is also uncontrolled there is little that can be done about high pool elevations at Long Branch Lake, other than to notify downstream interests. During the May floods, three other lakes, Hillsdale, Stockton, and Pomme de Terre, also rose into their increased surveillance zones, but again no problems were encountered. Truman Reservoir rose to an elevation of 724.4 feet, about one foot less than its increased surveillance level. The extreme drought conditions in Kansas eventually resulted in two lakes, Milford and Perry, falling to record low pool elevations later in 2002.

Operations at Milford and Tuttle Creek Lakes during the May through August periods are affected each year by the presence of two bird species, the Piping Plovers and Least Terns, listed on the Federal threatened and endangered species lists, respectively. The Act requires Federal agencies to ensure that their actions do not jeopardize the continued existence of a threatened or endangered species. In 1994, a population of Least Terns was located nesting on fly-ash spoils at Jeffrey Energy Center near Belvue, Kansas. The high water events of 1993 and 1995 resulted in many newly scoured sandbars along the Kansas River. Least Terns and Piping Plovers were first reported on some of these sandbars in 1995 and 1996. This was the first nesting of the Piping Plover ever recorded in Kansas. Beginning in 1998, the nesting locations were monitored throughout the breeding season to determine productivity by the species. Funding for the 1998 study was provided by the U.S. Fish and Wildlife Service (USFWS), and funding since then has been provided by the District. The District has agreed to pursue species monitoring through 2004, in accordance with a Biological Opinion addressing primarily Missouri River endangered species issues.

The District has developed a plan of operation to monitor the nesting areas and coordinate lake releases. During the 2001 and 2002 nesting seasons, the District contracted with

Dr. Roger Boyd of Baker University in Baldwin, KS, to monitor nesting activities. The District's Environmental Resources Section administered the contract and provided coordination with other agencies, including the U.S. Fish and Wildlife Service. Water Management staff in turn coordinated release decisions with the personnel in Environmental Resources Section and other District elements. In general, bird pairs tend to build their nests very close to the shoreline on scoured sandbars. Dr. Boyd locates the nests, and then the District establishes a maximum target stage at Wamego and Belvue to which Milford and Tuttle Creek lakes are regulated. During flood events, Water Management staff reduce releases from the two lakes in an attempt to keep the Kansas River from exceeding the target stages. Because of the 1 to 2-day travel time it takes for a change in release at the upstream projects to reach the downstream nesting sites, it is not always possible to have an impact on the downstream stages before the local inflows from a rainstorm flood the nesting sites. Nests can also be lost due to inclement weather like hail and from predation. Excess inflows to the lakes are stored in the flood control pools of the two lakes until downstream conditions allow the evacuation of the excess storage. In practice, this operation primarily affects Tuttle Creek Lake since inflows to Milford tend to be minimal during the period of concern. The reproductive success for the last seven years is irregular, but the studies by Dr. Boyd indicate that the success is comparable to other regional nesting sites like those at the Quivira National Wildlife Refuge.

In 2001, higher river flows prior to the nesting season restricted confirmed nesting locations to the Belvue site about 3 miles downstream of Belvue, Kansas. The first nests were located on May 25, although some of the nests were likely established as early as April 30. The Wamego target for restricting upstream reservoir releases was initially set at a stage of 4.5 feet, rising to 5.5 feet in August. Uncontrolled runoff from storms washed away the nests by the first week in June. The Piping Plovers did not renest after this event. Milford and Tuttle Creek Lakes stored a substantial amount of water during the storm events, and USFWS agreed to a release of the excess storage during the month of June. Seven Least Tern nests were reestablished in July. Most of the nests were destroyed by predators, hail, and uncontrolled runoff by early August. Two nests survived. Dr. Boyd determined that three fledglings probably survived to the end of the season on August 29. Tuttle Creek Lake rose to a pool elevation of 1088.9 in early June (multipurpose pool level 1075.0), followed by a rise to 1084.5 in early August. Milford rose to 1149.4 (multipurpose pool level 1144.4) in early June, followed by a rise to 1147.9 in August.

In 2002, releases from excess flood storage accumulated during the April and early May period were combined with higher uncontrolled inflows to ensure that early nesting occurred at higher sand bar elevations. After the initial nests were established dry weather conditions ensued and uncontrolled runoff was rarely a concern. Excess storage accumulated during the nesting season resulted in only minor rises into the flood control pools at Tuttle Creek and Milford Lakes prior to July 1. On July 2nd, lake releases were increased to meet navigation flow supplementation targets downstream. That afternoon, an agent from USFWS discovered a new nesting colony in the Kansas River reach downstream of Tuttle Creek Lake. After the District received notification, they immediately reduced releases. But since the releases had already been increased for a period of time, it was impossible to keep from inundating the lowest Tern nest.

During 2002, the low river flows contributed to ideal conditions for successful nesting. A total of four Piping Plover and 39 Least Tern nests were located and tracked. Although a large number of eggs were laid, predation was a serious problem. 28 nests were destroyed by predators, mostly coyotes; 4 were abandoned; 3 were destroyed during a storm; one was

disturbed by a human or a dog and abandoned. Only one Least Tern nest was destroyed by rising waters related to a reservoir release. There were 4 Piping Plovers and 7 Least Terns that successfully fledged by the end of the season on August 29.

On July 25, 2000, the Northwestern Division Commander signed a Record of Decision for Harlan County Lake in Nebraska adopting the Bureau of Reclamation's Final Environmental Impact Statement for the Republican River Basin Repayment and Long-Term Water Service Contracts. Harlan County Lake was constructed and operated for flood control, recreation, water quality, fish and wildlife, and irrigation. A substantial portion of the multipurpose pool is allocated to the irrigation function. The signing of the ROD resolved an issue between the Corps and Reclamation regarding operation of the irrigation and sediment storage in the pool dating back to the early years of the project. The ROD provides a plan that protects all project purposes affected by the declining upstream water resources. The water control plan now allows some water for irrigation to be withdrawn from the sediment pool during drought conditions. The lowest drawdown elevation is limited to a pool elevation of 1927.0. Water shortages are now shared between the various beneficial uses of the project. The elevations at the base of the normal irrigation pool and the base of the flood control pool were also adjusted to protect the authorized flood control function. Following a new sediment survey, a revised lake elevation-area-capacity table was placed into service effective January 2001. A revised Field Working Agreement between the Corps and Reclamation was signed on behalf of the Corps on July 17, 2001. Revisions to the Harlan County Lake Water Control Manual incorporating the changes were approved by the Division on May 10, 2001. A projected irrigation drawdown elevation is now computed in January of each year and confirmed in May. This provides irrigators an increased level of assurance regarding their annual water supplies.

Concurrently, the District analyzed a Harlan County dam safety concern regarding the hydrologic adequacy of the spillway tainter gates. Although the design was sufficient for the standards established at the time the dam was constructed in the late 1940's, the standards have been tightened in recent years. Until funding is obtained to repair the gates, the surcharge operating procedures have been adjusted to accommodate the deficiencies. The interim procedures were approved by the Division office in January 2003. The interim procedure increases the flood risks to downstream landowners. A public meeting will be held with downstream interests in FY 2003 to inform them of the possibility.

Lake sediment surveys are accomplished, as needed, at most Corps lakes. When the changes in sedimentation are significant, revised lake elevation-area-capacity tables are issued. During this reporting period, no new tables were placed into use. Soundings of Perry Lake were completed during 2001, but new area-capacity tables have yet to be generated.

Beginning in 1999, the Emergency Action Plans (EAP's) for all Corps lake projects were revised and distributed to the projects and the public. The EAP's constitute Volume II of each project's Operations and Maintenance Manual. They describe action plans and notification procedures for a range of emergencies, including a dam break scenario. Orientation meetings with local and state officials were completed in 2000. The District completed distribution of the revised plans in 2001. The inundation maps for Tuttle Creek were revised July 2002 in accordance with a hydrologic adequacy analysis completed during this reporting period. See a later section on Research and Special Studies for the description of special studies at Tuttle Creek Lake.

In addition to the EAP's, the District recently completed the revision and distribution of Dam Surveillance Plans for many of the Corps lake projects. The Plans constitute Volume III of each project's Operations and Maintenance Manual. They describe both routine surveillance procedures and the increased levels of surveillance needed as the lake rises into the upper reaches of the flood control pool. The revised plans for eight of the 18 Corps lakes were distributed in September and November 2002.

Inspection and maintenance activities at the lake projects occasionally require Water Management involvement. During a 5-year periodic inspection, releases from the affected lake may be stopped in order to perform inspections and maintenance on the outlet stilling basin and downstream channel. During this reporting period, periodic inspections were accomplished at Kanopolis Lake (September 2001), Pomme de Terre Lake (October 2001), and Pomona Lake (October 2001). A periodic inspection was also performed at Perry Lake in September 2002. During 2003, inspections will be required at Clinton, Blue Springs, Long Branch, Truman, and Stockton Lakes.

Service and emergency gate maintenance at both Perry and Tuttle Creek Lakes during this reporting period required temporary adjustment of releases from each project. Releases from Tuttle Creek were regulated in an attempt to keep the pool below elevation 1091 to minimize impacts to the contractor. Work on the gates at Perry required that the pool be lowered below the multipurpose level in September 2001. In 2002, one of the two service gates at Perry was removed for further work. Prior to the removal, the District tested the remaining service gate to ensure that it would function adequately under all gate openings. There was some concern that the asymmetric release through the outlet tunnel would result in some problems. The test was completed successfully on May 17, 2002, demonstrating that the single gate would release an adequate amount of water for all flood pool conditions.

In December, 2001, Pomona Lake was lowered to elevation 970 feet (4 feet below the normal multipurpose pool elevation) to allow repair work on the embankment to proceed. It was allowed to return to the normal pool level in April 2002. Similar work will be accomplished at Melvern Lake during the winter of 2002-03.

From mid-January to early February, 2002, Milford Lake was lowered to elevation 1142.9 feet, or 1.5 feet below its normal multipurpose level. The purpose was for Phase I construction work in a wetlands area near the upper end of the lake. Additional work will be accomplished during the winter of 2002-03, with the final phase expected for the fall of 2003.

Other dam safety concerns for which Water Management staff have provided data input and hydrologic studies include the following: At Wilson Dam, movement has been noted in the stilling basin walls. The movement led to a decision to temporarily remove a portion of the backfill behind the walls. Further temporary repairs were accomplished in FY 2002. During FY 2003, the permanent repair design will be completed, with the intent of awarding a repair contract in FY 2004. Studies have also been initiated to evaluate waterstops at Harry S. Truman Dam. Increased flows into the interior galleries were noted during the winter of 2000-01. Relief well rejuvenation and foundation drain cleaning is continuing at a number of projects.

***Bureau of Reclamation Projects - August 1, 2001 through July 31, 2002.***

Reservoir operations at the 11 Reclamation projects in the Kansas City District were carried out in accordance with normal regulation procedures during the period covered by this

report. At the Reclamation projects, all operations are scheduled for optimum benefits of the authorized project functions. Monthly, or as often as runoff and weather conditions dictate, Reclamation personnel evaluate the carryover storage and estimated inflow at each reservoir to determine whether excess water is anticipated. A rising pool in the spring benefits fish spawning in the lake as well as irrigation storage. Following the irrigation season drawdowns, herbaceous growth along the lake banks benefits fall waterfowl habitat and spring fish habitat. Inflows during the fall, winter, and spring are typically stored. If excess inflow is apparent, controlled releases are made to maximize lake and downstream benefits, including flood control. Appendix B includes pool elevation hydrographs at all Reclamation projects in the District, along with summary data providing an historical perspective.

The regulation of flood control storage in Reclamation reservoirs in the Kansas River basin has been assigned to the Kansas City District Water Management Section. When project inflows are sufficient to produce an encroachment into the flood pool, coordination is immediate between the two Federal agencies, and decisions are made regarding the regulation desired. Regulation orders are issued by Water Management staff to the Reclamation's Water Operations Group at the McCook Field Office in Nebraska. The McCook Field Office is responsible for issuing orders for both flood control and conservation releases to the Reservoir Superintendent. During this reporting period, there were only minor amounts of flood control storage accumulated at Reclamation projects due to the drought. Prior to the 2001 irrigation season, small flood control releases were needed at Harry Strunk and Waconda Lakes and Lovewell Reservoir. Inflows during the winter of 2001 and the spring of 2002 were again below normal. At the beginning of the 2002 irrigation season, only Harry Strunk Lake and Lovewell Reservoir had refilled. Minor flood control releases were needed from each of these lakes, but they were accomplished in conjunction with irrigation releases in June.

Details of the 2001 irrigation operations at Reclamation lakes are described in the earlier section on Irrigation. Carryover storage at the end of the 2001 irrigation season was below normal at most projects, with the exception of Keith Sebelius and Waconda Lakes, and Kirwin, Webster, and Cedar Bluff Reservoirs. Inflows during the winter and spring prior to the 2002 irrigation season were generally less than normal. With the most probable inflow conditions, Reclamation expected that irrigation districts would receive full supplies during the 2002 season at all projects except those served by Enders Reservoir and Keith Sebelius Lake. If inflows were less than normal, then irrigation districts taking water from Enders, Swanson, Hugh Butler, Harry Strunk, Keith Sebelius, Harlan County, and Lovewell could receive less than full supplies. At the beginning of the 2002 irrigation season, Bonny, Enders, Swanson, Hugh Butler, Keith Sebelius, Harlan County, Kirwin, Webster, and Waconda had not refilled or approached refill. Details on the 2002 irrigation season will not be available until the next Annual Report.

The water service contracts for nine irrigation districts in the Nebraska-Kansas Projects area were scheduled to expire between 2000 and 2007. Some are contracts that were extended temporarily in accordance with a law passed in 1996. The long-term water service contracts with the Frenchman-Cambridge, Frenchman Valley, Kansas Bostwick, Nebraska Bostwick, and Almena Irrigation Districts were renewed on July 25, 2000, confirmed in District Court, and become effective on January 1, 2001. The process for renewing long-term water service contracts with the Kirwin and Webster Irrigation Districts was begun in 1997 but temporarily suspended. In March 2001, Reclamation reinitiated contract negotiations with the districts. On August 3, 2001, the remaining issues were resolved, and a draft Environmental Assessment and

revised contracts were made available for public review in December. Execution of the contracts was scheduled for 2002.

Continuing work on rehabilitating all piezometer wells and upgrading the associated equipment was completed by the end of 2001. A program was initiated in 2001 to examine all toe drain systems over the next few years. Minor repair work was accomplished in 2001 at Harry Strunk, Hugh Butler, Swanson, Norton, and Kirwin projects.

The Safety of Dams program has been an important concern at Reclamation projects in recent years. Annual site inspections were completed at each dam in 2001. Emergency Action Plans (EAP) have been updated at all Reclamation projects in recent years. Comprehensive Facility Reviews (comparable to the Corps 5-year periodic inspections) were scheduled for Bonny, Norton, Kirwin, Webster, and Cedar Bluff Dam's in 2002. Reclamation's Denver Technical Center is continuing Safety of Dams investigations at Bonny, Enders, Red Willow, and Norton Dams. Repair work under the Safety of Dams program was accomplished at Enders and Red Willow Dams in 2001. Seepage at Enders Dam will continue until the 2004 CFR, when the need for additional corrective measures will be evaluated. Emergency radios have been installed at each of the projects as a backup communication system to contact local emergency management officials during emergency events. Revised Standard Operating Procedure (SOP) manuals at Bonny, Keith Sebelius (Norton Dam), Webster, and Cedar Bluff are currently being reviewed, and Reclamation expects they will be republished in 2002.

Lake sediment surveys were accomplished at Cedar Bluff Reservoir and Keith Sebelius Lake in 2000. The revised area-capacity tables became effective in January 2002. Waconda Lake was resurveyed in 2001, and the revised capacity tables are expected to be distributed in January 2003.

***Proposed Operations - August 2002 Through Calendar Year 2003.***

Corps and Reclamation storage lakes in the Kansas City District contained a total of 4,988,926 AF of storage on August 1, 2002. This total is 812,321 AF less than the volume in storage on this date one year earlier. Of the total volume in storage, 582,201 AF (12 percent) were contained in the Reclamation lakes and 4,406,725 AF (88 percent) were contained in the Corps projects. The total storage in the Reclamation lakes is a decrease of 150,311 AF compared to August 1, 2001, mainly due to lower than normal inflows and high irrigation demand.

Sixteen of the eighteen Corps lakes and one of the eleven Reclamation lakes in the District contained storage in their flood control pools on August 1, 2002. The occupied flood control storage amounted to 64,959 AF, less than 1 percent of the total system flood control space available. This volume compares to 465,652 AF of flood control storage space occupied on August 1, 2001. In 2001, a large portion of the flood control storage had been accumulated in Tuttle Creek Lake due to release restrictions needed to protect downstream nesting sites (see the earlier section describing current year operations at Corps projects). In August 2002, drought had eliminated almost all of the flood control storage. Most of the remaining storage was in Stockton, related to the May 2002 flood event, and that storage was evacuated by mid-month. At this time, normal operations are anticipated through calendar year 2003.

**MAJOR REGULATION PROBLEMS AND PROPOSED SOLUTIONS.**

During this reporting period, minor deviations from the approved water control plans were obtained for just two Corps projects. In 2001, high inflows to Rathbun Lake resulted in the highest March pool elevations ever reached. After the project personnel coordinated with downstream agricultural interests, the Division approved a minor deviation for March through May to allow releases of up to 1,500 cfs from the dam. In June, the Division approved an extension of the deviation through August. Project personnel conducted downstream channel reconnaissance during the high releases. They found that the State and private efforts to get bottomland farm acreage converted to wetlands had been very successful. After project personnel met with downstream interests on the issue, the District decided to seek a similar deviation for Rathbun Lake releases in 2002. Water management staff also included revisions to downstream channel capacity targets based on the earlier channel recons and after consultation with the National Weather Service. The deviation was approved by the Division office in May 2002, effective through December 2002. The District then decided to pursue a water control manual revision to incorporate the revised release plan and downstream channel capacities into the permanent water control plan. Funding for the special item work has not been approved, and it is uncertain when the revision will be ready for public review.

In May 2002, a major fish kill occurred downstream of Bagnell Dam, related to high spill releases during a flood event. Missouri Department of Conservation requested a large reduction in Truman releases to give them time to evaluate the fish kill. The District worked with SWPA, MDC, Ameren, and the Division approving office to develop an alternative plan that would enable a short-term reduction in releases but then provide for a gradual return to normal operations while Ameren and MDC conducted tests with varying levels of Bagnell spillway releases. In order to minimize the impact on SWPA and the upstream landowners, the Division office approved a deviation to allow an extended period of Phase II releases from Truman Reservoir, so that the time the lake would be above the 710-foot critical elevation was kept about the same as with normal operations.

Recent Kansas River regulation concerns led to a decision in 2000 to begin the development of a Kansas River Basin reservoir system simulation model. The model will provide a mechanism for preparing timely and adequate evaluations of different operation procedures and the assessment of reservoir operational impacts on the lower Kansas River. The regulation concerns include managing releases for Least Terns and Piping Plovers as required under the Endangered Species Act, modifying Kansas River operations to conform with recommendations included in a recent U. S. Fish and Wildlife Service Biological Opinion on Missouri River Basin operations, providing releases in the lower Kansas River for water quality and supplemental navigation flows while accommodating increasing water supply needs providing for recreational and fish and wildlife needs on the lakes and downstream of the lakes, evaluating the impacts of lake fluctuation plans proposed by the State in more detail than currently available, and meeting concerns regarding channel capacities, floodplain development, and other changes in operating considerations for flood control.

Funding for the development of a Kansas River system model using the Riverware modeling software was obtained for the 2001-03 fiscal years, and a water management team is working with the software developer to complete the coding and calibration of the baseline model. Riverware was developed and is supported by the Center for Advanced Decision Support

for Water and Environmental Systems (CADSWES), University of Colorado. After the baseline system model is developed, the alternative operations will be evaluated, probably in 2004.

## WATER CONTROL MANUALS.

This section serves to provide the information requested in paragraph 13c of ER 1110-2-240, dated October 8, 1982, regarding the status of water control manuals.

**Table 3: Project Manual Status and Revision Schedule**

| Reservoir/Lake | Stream/River | Owner | Report Status | Submission Schedule |
|---|---|---|---|---|
| **Nebraska** | | | | |
| Master Manual | Republican | CE | Updated final submitted to NWD for review July 28, 1977 | |
| Harlan County | Republican | CE | Revision approved by NWD May 10, 2001 | |
| Harry Strunk | Medicine Creek | BR | Approved by NWD July 12, 1974 | |
| Enders | Frenchman Creek | BR | Approved by NWD March 26, 1973 | |
| Swanson | Republican | BR | Flood Control Regulation approved by OCE October 6, 1969 | |
| Hugh Butler | Red Willow Creek | BR | Flood Control Regulation approved by OCE November 21, 1969 | |
| **Colorado** | | | | |
| Bonny | S. Fork Republican | BR | Approved by OCE October 6, 1969 | |
| **Kansas** | | | | |
| Lovewell | White Rock Creek | BR | Approved by OCE April 9, 1969 subject to comments | |
| Milford | Republican | CE | Approved December 1984. Minor revision approved Jan 1995 | |
| Norton | Prairie Dog Creek | BR | Approved August 28, 1974 | |
| Master Manual | Smoky Hill | CE | Approved March 28, 1975 | |
| Kanopolis | Smoky Hill | CE | Revision submitted to NWD October 30, 1984 | |
| Cedar Bluff | Smoky Hill | BR | Approved by NWD September 25, 1975 | |
| Kirwin | N. Fork Solomon | BR | Approved by NWD February 6, 1974 | |
| Webster | S. Fork Solomon | BR | Approved by NWD July 16, 1975 | |
| Wilson | Saline | CE | Revision submitted to NWD June 13, 1997 | |
| Waconda | Solomon River | BR | Approved by NWD July 12, 1972 | |
| Master Manual | Kansas | CE | Approved by OCE March 22, 1967 subject to comments | Dec 2006 |
| Tuttle Creek | Big Blue | CE | Approved April 16, 1974. Minor revision approved January 1995 | |
| Perry | Delaware | CE | Approved July 1973. Minor revision approved January 1995 | |
| Clinton | Wakarusa | CE | Approved February 12, 1980 | |
| Master Manual | Osage River | CE | Approved by OCE Sep 21, 70 subject to NWD, OCE comments | |
| Pomona | 110 Mile Creek | CE | Approved February 1973 | |
| Melvern | Marais Des Cygnes | CE | Approved June 27, 1985 | |
| Hillsdale | Big Bull Creek | CE | Approved June 19, 1985 | Sep 2003 |
| **Missouri** | | | | |
| Pomme De Terre | Pomme De Terre | CE | Revision submitted to NWD September 1996 | |
| Harry S. Truman | Osage | CE | Interim manual approved by NWD May 12, 1981. Minor revision approved April 1996 | |
| Stockton | Sac | CE | Approved August 21, 1975 | |
| Smithville | Little Platte | CE | Approved August 12, 1979 | |
| Long Branch | E. Fk Ltl. Chariton | CE | Interim manual approved November 21, 1978 | |
| Longview | Little Blue | CE | Approved February 15, 1994 | |
| Blue Springs | E. Fork Little Blue | CE | Approved January 27, 1994 subject to comments. Revision submitted to NWD December 1994 | |
| **Iowa** | | | | |
| Rathbun | Chariton | CE | Approved October 19, 1981 | |

### *Manual Status.*

Water control plans prepared for specific projects and basins within the Kansas City District have been documented in appropriate manuals as directed by paragraph 6c of the above referenced ER. Paragraph 6c also directs that water control plans be revised as necessary to

conform with changing requirements resulting from developments in the project area and downstream, improvements in technology, new legislation, or other relevant factors, provided such revisions comply with existing Federal regulations and established Corps of Engineers policy.

The water control manual for Pomme de Terre Lake was reviewed by the Division and returned for corrections and clarifications on March 18, 1997. The water control manual for Wilson Lake was submitted to the Division for review on June 13, 1997. On May 10, 2001, the Division approved a revision to the water control manual for Harlan County Lake. The Hillsdale Lake manual is currently being updated under an awarded contract task order. The Rathbun Lake project office and the Water Management Section are working when time is available to complete the reports needed to evaluate a possible revision to the Rathbun Lake water control manual, but no schedule has been set due to funding uncertainties. All of the water control manuals for District lake projects need updating. Special item funding through the District Operations and Maintenance budget has been requested, but due to the funding constraints it is unlikely that any of the manual revisions will receive approval. The current status and the revision schedule for all project water control manuals are shown on Table 3. The revision of the Kansas Lake Master Water Control Manual could be funded as an extension of the Riverware modeling effort. Therefore, it is shown as a separate item on 3, but it should be emphasized that funding for the revision has not yet been approved.

***Other Reports.***

Plates 2A-E list project data showing the date impoundment of storage began, the date the multipurpose pool (the active conservation pool in USBR projects) first filled, and the current status of Standing Instructions for Regulation of Storage in Corps of Engineers Lakes.

As indicated in Engineering Manual 1110-2-3600, it is essential that project operators (dam tenders, operations managers, power plant superintendents) at the various flood control and multiple-purpose reservoirs be supplied with regulation schedules to be followed in case of communication failure. These regulation schedules should be followed in case of communication failure with the headquarters from which instructions are normally issued during flood situations. Standing Instructions have not yet been issued for Harry S. Truman Reservoir, Clinton, Hillsdale, Long Branch, Smithville, Longview, and Blue Springs Lakes.

## HYDROLOGIC DATA COLLECTION.

The primary objectives of Kansas City District's hydrologic data program is to provide information on precipitation and stream flow characteristics occurring over and within a particular area for a given period of time. These data are used for many purposes, including the design, construction, and maintenance of a wide variety of structures in and along streams; the management of lake releases during floods; the production of hydropower; the design and maintenance of navigation facilities; the control of pollution; the management of flood plains; the development of recreational facilities; the design of highway bridges and culverts; the establishing and administering of water rights and compacts; and the resolving of political, social, and legal water problems. As with any program, however, the constraints on funds and manpower and the usefulness of the data obtained will determine to what extent the program will, or should, be pursued at any particular point in time. The overall program of observing, monitoring, and collecting hydrologic and meteorological data in the District is quite extensive

yet flexible to meet operational and economic needs. Brief descriptions of the various types of data collection now being utilized are presented in the following paragraphs.

***Collection and Processing of Water Control Data.***

Hydrologic data such as precipitation, stream flow, and lake information are collected in the Kansas City District by the following: individual observers, Corps project offices, the National Weather Service (NWS), the Geological Survey (USGS), the Bureau of Reclamation, and certain state agencies. Several different methods of communication are used in the Kansas City District to collect these data. Telephone and fax communications are used to collect the data that come directly to the Water Management Section from observers and Corps field personnel. Operational and hydrologic data for the Reclamation projects are transferred by email or fax from the field office in McCook, Nebraska. Stream flow and stage data are transmitted through a satellite downlink and a Datawise Receive Station from USGS transmitters or directly from automated data collection platforms. NWS precipitation data and river forecasts are transferred automatically between agency computer servers. Weather data, radar observations, and a large amount of subsidiary information are also available through the Internet or direct computer ties. Data received by the District is entered onto the Water Management Section's Unix server database by both automated and manual methods, depending on the data source. Software developed by Water Management Section staff provides a means to view, screen, and process the data for graphical and reporting purposes. The data is then uploaded to the Penstock database located at the Corps Reservoir Control Center in Omaha. Selected data reports are transmitted back to the NWS server at the same time. Once entered into the Division database, the data and reports are available to users Division-wide for forecasting, data listings, reports, bulletins, charts, program processing, and modeling. Daily data and project reports are also available to the public at the Section's web site, http://www.nwk.usace.army.mil/current.html

In 2001, Water Management Section staff initiated an Approved Quality Control Plan to ensure that its data processing, reports, and engineering documents meet District and Corps quality standards. Customers needing Section products on a daily basis include: the Southwestern Power Administration, the National Weather Service, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the States of Kansas, Missouri, Nebraska, and Iowa, and the general public. Corps elements using Section products include the Reservoir Control Center in Omaha, the District's Emergency Management Branch, and the Operation Managers at each lake project.

In order to provide an extended uninterrupted power supply (UPS) during emergency operations, in 2001 the Section acquired the necessary racks and moved its data servers to the secure computer room in the Federal Building. The next step will be to connect the computer room into the portable generator at the emergency operations center.

In 2003, the District and Division software to manage the water control data system will be converted to the Corps of Engineers Water Management System (CWMS), a nation-wide data management platform for the entire Corps. Implementation began in 2002. CWMS is an enterprise-wide information technology project, which will standardize all water management offices under one system. CWMS will provide standard tools, database, data sources, model software, and modeling methodology. This system is being implemented on a regional aspect in the Northwestern Division. The final deployment will consist of one regional system deployed on a master server in the Reservoir Control Center and two mirror servers located at Omaha and

Kansas City District offices. Information technology staff in the Division office will centrally administer the automatic data processing infrastructure underlying the CWMS system. The CWMS software configuration will be managed locally at each office.

To support the CWMS deployment, in FY 2001 the Water Management Section acquired a Sun Blade 1000 workstation. The CWMS software including the Oracle database was loaded onto this workstation. Staff from the Hydrologic Engineering Center (HEC) provided onsite CWMS training in the District November 14-16, 2001. The CWMS system was initially tested at the Reservoir Control Center. This test discovered that Oracle data replication was not functional with the database design currently used in the region. A solution to this replication discrepancy was developed in FY 2002. The Water Management Section staff is currently expanding the configuration of real-time data processing features of CWMS. HMS models of subbasins in the Kansas River basin are being developed to test the NEXRAD gridded rainfall/runoff modeling capabilities in CWMS. CWMS will be run concurrently with the existing water management system until all mission-critical requirements have been consistently met. At that point, the current system will be retired.

***Automatic Remote Sensors.***

Data Collection Platforms (DCP's) are the primary means by which Kansas City District obtains remote sensing data on stream stages and lake elevations. The DCP is a sophisticated device that collects the information from a USGS manometer and transmits the data to a GOES satellite for subsequent retrieval by the National Environmental Satellite, Data, and Information Service (NESDIS) at Wallups Island, Virginia. NESDIS then rebroadcasts all data over a single high-speed channel on a Domestic Communications Satellite (DOMSAT). The Water Management Section receives DCP data from NESDIS or directly from the DCP's with a DOMSAT receive station. Maintenance of the DCP's is performed by the USGS under contract with the Corps of Engineers. In 2002, the District supported 148 permanent DCP's. A breakdown of the total number of DCP's, by states, shows 53 units in Missouri, 69 in Kansas, 18 in Nebraska, and 8 in Iowa. The District also contracted with USGS to install four temporary stream gages at sites along the Kansas River to monitor river conditions during the May through August period when endangered/threatened bird species were nesting. Additional temporary gages have also been installed along the Blue River to better define conveyance and hydrologic characteristics and along the Missouri River from Napoleon to Hermann to better define phase I, II, and III flow targets and channel degradation trends.

***Cooperative Hydrologic Programs.***

Constraints on funds and manpower do not allow the Corps to administer an independent data collection program that satisfies all of its needs. Therefore, assistance is sought from other cooperating agencies. A nationwide program of data collection at selected stream gauging stations has been administered for a number of years by the U.S. Geological Survey (USGS). A similar network of reporting stations has been operated by the National Weather Service (NWS) for their river forecasting services. Arrangements have also been made with the USGS through which they supplement their network of reporting stations, or increase the frequency of reports, to better satisfy Corps needs. A similar program had been maintained with the NWS for a number of years, but due to budget constraints it was terminated at the end of FY 2001. The program, designated the "Cooperative Hydrologic Reporting Network," is administered by the

USGS and supported by funds transferred from the Corps. Arrangements for the services provided are made with USGS representatives in each state and submitted annually to the Chief of Engineers, through the Division Commander, for review and approval. The District also funds a small number of its own local stream gauge observers to satisfy the needs of individual projects. These include four locations with paid observers and an additional seven locations with unpaid observers. The contracts for these individuals will be terminated at the end of 2002. A summary of funds expended for data collection purposes during the report period is included in the Personnel and Funding section at the end of this report.

***Water Quality Investigations and Monitoring Activities.***

The Water Quality Unit's (PM-PR-W) 2002 activities were highlighted by the continuation of long-term studies of the Big Bull Creek (Hillsdale Lake), Chariton River (Rathbun Lake), and Little Platte River (Smithville Lake) watersheds. The Big Bull watershed studies with EPA 319 funding involve numerous Federal, State, county, and local agencies, as well as citizen groups, in quantifying the levels of nutrients and herbicides throughout the watershed and implementing pollution reduction strategies. The latter include increased use of best management practices on agricultural lands and the use of constructed wetlands to improve the quality of point-source effluents. PM-PR-W teamed with Hillsdale Lake project personnel to perform the lake-monitoring portion of the work, which included monthly insitu profiling of temperature, dissolved oxygen, conductivity, pH, and redox; secchi and photic zone measurements; sample collection and filtration; chlorophyll, turbidity, immunoassay herbicide, and suspended solids analyses; coordination with other laboratories; and data management.

In the sixth year of the multi-agency, cooperative study of the Chariton River watershed, PM-PR-W and Rathbun Lake project personnel teamed to perform monthly surveys of four lake stations and the outlet. Sampling of 15 tributaries was carried out by Iowa State University Limnology Laboratory personnel. PM-PR-W performed chlorophyll, turbidity, suspended solids, and immunoassay herbicide analyses while the Chemical and Materials Quality Assurance Laboratory (CMQAL) performed nitrogen and phosphorous group, total and dissolved iron and manganese, total and dissolved organic carbon, and QAQC pesticide analyses. PM-PR-W continued to provide data management for the long-term study. As in the Big Bull Creek watershed studies, the Natural Resources Conservation Service (NRCS) with major support from EPA 319 funding assisted in obtaining the voluntary support of the agricultural community in reducing the amount of non-point source runoff.

For its part in the Little Platte River watershed studies, PM-PR-W teamed with Smithville Lake project personnel to perform monthly surveys of the three lake stations, the outlet, and the major tributary. Physical, chemical, and biological analyses noted above were performed by PM-PR-W and CMQAL. Reports were provided to various members of the study group and to the general public.

Two surveys of Truman Reservoir and one survey each at Stockton, Pomme de Terre, Longview, and Blue Springs lakes were also conducted by PM-PR-W in 2002.

In addition the following lake projects supported the District water quality monitoring effort in 2002: Long Branch, Clinton, Perry, Milford, Tuttle Creek, Wilson, Kanopolis, Pomona, Melvern, and Harlan County. Approximately 140 samples per month during April-September were collected by project personnel at lake, outlet, and inflow stations and analyzed by

PM-PR-W and CMQAL for herbicides and nutrients, respectively. Also, PM-PR-W provided equipment, training, and technical support to the cooperating projects. Reports were provided to each of the participating projects and placed on the Internet for access by other agencies and the public.

Other activities to support the sampling and analytical capabilities of PM-PR-W were data management, procurement of supplies and equipment, maintenance and calibration of field and laboratory equipment, and maintenance of mobile laboratory and marine equipment. The unit also carried out a quality assurance/quality control (QA/QC) program with the cooperating laboratories.

***Sediment Observations.***

During the Fiscal Year 2002 reporting period, the Kansas City District survey crews surveyed cross sections at stream channel degradation ranges downstream of Perry Dam as part of a regular cycle of monitoring. Perry Dam is located in eastern Kansas. The cross sections were plotted and compared to previous surveys.

The Perry Lake project degradation ranges were last surveyed in 1967 and 1979. For this iteration, 7 of the 9 ranges were relocated, surveyed, and compared to the previous surveys. Ranges 9 through 4 stretch from the dam approximately five miles along the Delaware River to the mouth of the river. Range 4 near the mouth appeared to be destroyed due to re-channelizing of the Delaware River at the mouth. The remaining three ranges are located along the Kansas River from the mouth of the Delaware to just below Lecompton, KS. Range 2 had been relocated the prior winter, but couldn't be retrieved due to thick brush. Ranges 8 and 9 show very little degradation of the channel, but there has been 5 to 10 feet of bank erosion on each bank since 1979. Range 7 shows less than two feet of channel degradation but 50-60 feet of erosion on the right bank. At ranges 6 and 7, there has been 5 feet of channel degradation since 1979 with 5-10 feet of erosion on each bank. Range 3 shows very little change in the channel or along the banks. At range 1, there has been approximately 300 feet of erosion along the left bank related to a change in the orientation of the channel at this location.

The land portion of the sedimentation range surveys at Perry Lake was completed during this reporting period. The range soundings running across the lake were completed in April and May 2001. After digital terrain models are completed, new elevation-area-capacity tables will be developed for the lake.

Through an interagency cooperative agreement with the U.S. Geological Survey (USGS), the District collects point, depth integrated, and bed sediment samples at three Missouri River stations and two inflow stations to Harry S. Truman Reservoir. The Missouri River data at St. Joseph, Kansas City, and Hermann include point velocities. Laboratory analyses are performed at the USGS facility at Rolla, Missouri, and the results are stored in their database. The USGS publishes the suspended sediment load data for the Schell City and Clinton stations on the Osage River upstream of Truman Reservoir.

In March, additional survey data was collected on the Linn Creek arm of Lake of the Ozarks to complete a digital terrain model developed by the District. The data was used by the Federal Emergency Management Agency for a flood insurance study. Also in March, District office personnel assigned to the sedimentation function assisted the survey crew with completing the Missouri River semi-annual water surface profile. In May, the team surveyed cross sections

and measured bridges on the Blue River as part of a flood study. In May, District staff assisted with the coordination of two Missouri River Inspection trips to examine navigation structures and problem areas. In June 2002, we gathered survey data in and around Grain Valley, MO as part of a flood study. From July through September the staff assisted the Water Quality team with collecting and analyzing water samples from District lakes.

**RESEARCH AND STUDIES.**

As part of a continual process, the Corps Dam Safety Assurance Program reviews the safety of existing dams and considers new data or state-of-the-art design and construction methods for severe earthquake and extreme flood design. Tuttle Creek Dam is in a region that has experienced moderate to large earthquakes. Evaluations of Tuttle Creek Dam that have included worldwide experts, using state-of-the-art techniques, show that the dam is at risk of significant damage by a moderate earthquake to the point that an uncontrolled release of the lake is possible. Although the probability of an earthquake of the size necessary to damage the dam is very small, due to the potential consequences this possibility is being taken with all seriousness.

At the same time, evaluations using state-of-the art computer models were performed on Tuttle Creek Dam under what is believed to be the worst possible storm that could ever occur in the area, the spillway design flood. These evaluations show that the floodwaters captured by the dam would cause a slightly higher lake level than originally anticipated. The revised flood modeling assumes that approximately 24 inches of rain falls within the drainage basin when the lake is already full due to previous storms. The runoff would fill the lake to near the top of the dam and result in a flow through the spillway that would be 10 times greater than during the 1993 flood. Calculations show that when the lake is at its maximum elevation wind driven waves could splash over the top of the dam. Another entirely separate evaluation also shows that the spillway gate arms may not be strong enough to withstand the stresses of opening the gates when the lake level is near the top of the gates.

The necessary repairs to address wave protection and strengthening of the gates are relatively simple compared to the earthquake concerns, and the structural repairs will be incorporated into any plan to address the earthquake issues. The spillway gates can be strengthened to meet current design criteria, and concrete highway divider barriers can be added to the top of the dam to provide wave protection.

A range of alternatives from minimizing risk to a total replacement of the dam is being considered to address the earthquake concerns at Tuttle Creek Dam. Minimizing risks can include variations on improved emergency planning, better downstream flood plain management, or lowering normal lake levels. Structural improvements to the dam can include improved seepage control, stabilizing the soil under the dam, and enlarging the dam. The studies have determined that the design of the intake tower and outlet works is adequate under current standards.

The identified problems, the potential alternatives, and the schedule to address the concerns are discussed in more detail on the District web site at
http://www.nwk.usace.army.mil/tcdam
An Initial Evaluation Report dated July 1996 identified the potential problems and justified the need to proceed with detailed studies. Those studies were begun immediately afterward. Meetings with government agencies and affected communities were held during the March

through May 2001 period to review the initial results of the detailed studies. A draft evaluation report and environmental impact statement was issued for public review in May 2002, after which the evaluation report and EIS will be finalized. A Record Of Decision is expected to be signed by October 2002, after which implementation of the selected plan to address the earthquake risks will begin. If an alternative is selected that requires modification of the dam, further investigations and the design of any repairs would extend over about two years, and actual full-scale construction work could be initiated during the fall of 2004.

Work on the earthquake concerns at Tuttle Creek Dam will proceed independently of a proposal by a private company, Symbiotics LLC, to install a small hydroelectric generator in the dam. In April, 2001, Symbiotics filed a Preliminary Permit Application with the Federal Energy Regulatory Commission to conduct environmental reviews and preliminary design work over the next three years. The application may be viewed at the web link
http://rimsweb1.ferc.fed.us/rims.q?rp2~intro
The Corps does not have any statutory role in the development or submission of this application, but the Corps has requested that it be consulted regarding the proposed studies. Similar permit applications were filed for Milford, Glen Elder, Pomme de Terre, Stockton, and Perry Lakes.

## TRAINING AND METHODS.

Training of Water Management Section staff progresses as time and scheduling permit. Technical abilities are enhanced as individuals continue to pursue courses on their own initiative. During the period of this report, Section employees participated in the training courses listed in Table 4. In addition, all staff attended BQP and CorpsPath training and on on-site DECODES training class to be used with CWMS.

**Table 4: Staff Training**

| Employee | Course or Training |
|---|---|
| Alan Bruns | Riverware: Intro to Rule-Based Sim |
| Jan Doughman | CWMS Orientation |
| Paul Hansen | System Administration Security<br>Network Management Security |
| Debbie Noble | Hydrologic Engineering for Planning |
| Edward Parker | Riverware: Intro to Rule-Based Sim |
| Steve Spaulding | Riverware: Intro to Rule-Based Sim |

## PERSONNEL AND FUNDING.

### *Personnel.*

Authorized positions of the Water Management Section at the close of this reporting period (July 31, 2002) consisted of one Supervisory Hydraulic Engineer, four Hydraulic Engineers, one Hydrologist, and three Hydrologic Technicians. At the end of this reporting period, two positions in the Section were vacant. A listing of the personnel currently employed in the Section by name and title is shown in Table 5.

**Table 5: Water Management Section Personnel**

| Employee | Grade |
|---|---|
| Chief (1) | GS-13 |
| Alan Bruns (3) | GS-12 |
| Jan Doughman (4) | GS-11 |
| Vacant (2) | GS-12 |
| Jerry Holtz (4) | GS-11 |
| Jim Knapp (2) | GS-12 |
| Debbie Noble (4) | GS-10 |
| Edward Parker (2) | GS-12 |
| Steve Spaulding (2) | GS-12 |

**Job Title**
(1) Supervisory Hydraulic Engineer, vacant as of April 2002
(2) Hydraulic Engineer, one vacant position as of November 2001
(3) Hydrologist
(4) Hydrologic Technician

***Funding.***

Activities of the Water Management Section are funded from the following sources:

Planning.

Part of the funds appropriated for survey reports, flood plain information studies, and project planning studies are assigned to the Water Management Section for special studies if water control plans or associated studies are included in connection with the planning and design of projects in the Kansas City District.

Operations and Maintenance.

Operation of the existing lakes and reservoirs in the Kansas City District requires stream flow forecasting, water control planning, stream gauging, and other related activities for each authorized function at Corps of Engineers projects, and for the flood control function at Bureau of Reclamation projects. Operation and maintenance funds are used for these purposes.

Technical Services and Flood Emergency.

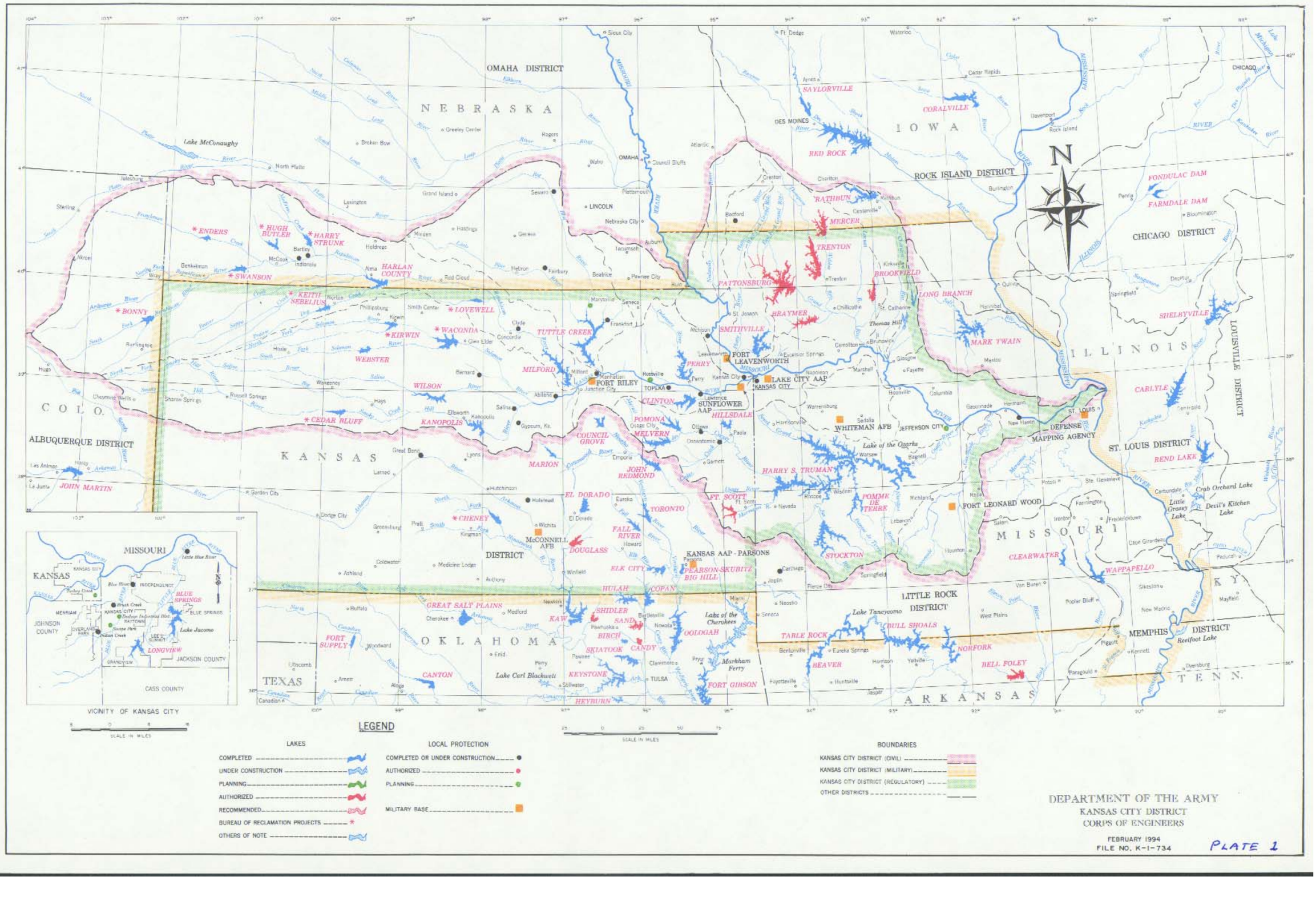
Technical services provided to non-Federal interests, flood emergency operations, post flood reports, and the annual flood report are tasks assigned to the Water Management Section. These activities vary from year to year. Special accounts are provided for these services.

Data Collection Programs.

In Fiscal Year 2002, rainfall reporting from the lake projects and automated precipitation measuring equipment at stream gage sites reported in real time is replacing the manual reporting system formerly used by the National Weather Service. There are no additional costs associated with the FY 2002 program.

The Cooperative Stream Gauging Program with the four U.S. Geological Survey districts (Kansas, Nebraska, Iowa, and Missouri) includes 148 stations.

Stage data were also obtained by the Kansas City District during the period of this report from 11 independent stations, either under contract or where supplies are issued for the purpose of data collection. Four of the locations have paid observers, and seven locations have unpaid observers in cooperating agencies.


OMAHA DISTRICT
NEBRASKA
IOWA
ROCK ISLAND DISTRICT
CHICAGO DISTRICT
ILLINOIS
LOUISVILLE DISTRICT
ST. LOUIS DISTRICT
MISSOURI
KANSAS
COLO.
OKLAHOMA
TEXAS
ARKANSAS
KY.
TENN.
ALBUQUERQUE DISTRICT
KANSAS CITY DISTRICT
LITTLE ROCK DISTRICT
MEMPHIS DISTRICT
Lake McConaughy
SAYLORVILLE
CORALVILLE
RED ROCK
RATHBUN
MERCER
TRENTON
PATTONSBURG
BRAYMER
SMITHVILLE
BROOKFIELD
LONG BRANCH
MARK TWAIN
FONDULAC DAM
FARMDALE DAM
SHELBYVILLE
CARLYLE
REND LAKE
ENDERS
HUGH BUTLER
HARRY STRUNK
SWANSON
HARLAN COUNTY
KEITH SEBELIUS
BONNY
LOVEWELL
WACONDA
KIRWIN
WEBSTER
TUTTLE CREEK
MILFORD
WILSON
CLINTON
CEDAR BLUFF
KANOPOLIS
POMONA
MELVERN
COUNCIL GROVE
MARION
JOHN REDMOND
HILLSDALE
PERRY
FORT LEAVENWORTH
LAKE CITY AAP
KANSAS CITY
SUNFLOWER AAP
FORT RILEY
TOPEKA
WHITEMAN AFB
JEFFERSON CITY
DEFENSE MAPPING AGENCY
HARRY S. TRUMAN
POMME DE TERRE
STOCKTON
CLEARWATER
WAPPAPELLO
FORT LEONARD WOOD
JOHN MARTIN
CHENEY
EL DORADO
TORONTO
FALL RIVER
DOUGLASS
McCONNELL AFB
ELK CITY
HULAH
COPAN
GREAT SALT PLAINS
KAW
SHIDLER
SAND
BIRCH
SKIATOOK
CANDY
KEYSTONE
FORT SUPPLY
CANTON
Lake Carl Blackwell
Markham Ferry
Lake of the Cherokees
OOLOGAH
FORT GIBSON
KANSAS AAP - PARSONS
PEARSON-SKUBITZ BIG HILL
FT. SCOTT
TABLE ROCK
BULL SHOALS
NORFORK
BEAVER
BELL FOLEY
Lake Tanycomo
Crab Orchard Lake
Little Grassy Lake
Devil's Kitchen Lake
Reelfoot Lake
VICINITY OF KANSAS CITY
MISSOURI
KANSAS
JOHNSON COUNTY
JACKSON COUNTY
CASS COUNTY
BLUE SPRINGS
LONGVIEW
Lake Jacomo
SCALE IN MILES
LEGEND
LAKES
COMPLETED
UNDER CONSTRUCTION
PLANNING
AUTHORIZED
RECOMMENDED
BUREAU OF RECLAMATION PROJECTS
OTHERS OF NOTE
LOCAL PROTECTION
COMPLETED OR UNDER CONSTRUCTION
AUTHORIZED
PLANNING
MILITARY BASE
BOUNDARIES
KANSAS CITY DISTRICT (CIVIL)
KANSAS CITY DISTRICT (MILITARY)
KANSAS CITY DISTRICT (REGULATORY)
OTHER DISTRICTS
DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
FEBRUARY 1994
FILE NO. K-1-734
PLATE 1

| SUBJECT | MELVERN LAKE | POMONA LAKE | HILLSDALE LAKE | STOCKTON LAKE | POMME DE TERRE LAKE | HARRY S. TRUMAN RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Melvern, KS | Near Pomona, KS | Near Paola, KS | Near Stockton, MO | Near Hermitage MO | Near Warsaw, MO | (2) Damming height is from the original riverbed to the top of the flood control pool. |
| Stream / River | Marais des Cygnes River | 110 Mile Creek | Big Bull Creek | Sac River | Pomme de Terre River | Osage River | (3) Based on latest available storage data. The revision dates of the current area - capacity tables are indicated below with the effective dates in parentheses: |
| Miles above Mouth | 175.4 | 8.3 | 18.2 | 51.4 | 45.6 | 175.1 | Melvern, February 1986 (effective March 1, 1986) |
| Contributing Drainage Area, square miles | 349 | 322 | 144 | 1,160 | 611 | 8,914 (4) | Pomona, March 1990 (effective April 1, 1990) |
| Approximate Length of Full Reservoir, miles | 22 | 12 | 15 | 24 | 28 | 122 | Hillsdale, 1969 (initial) |
| Shoreline, miles (1) | 101 | 52 | 51 | 298 | 113 | 958 | Stockton, February 1988 (effective May 1, 1988) |
| Maximum Discharge of Record nr Dam Site | 68,500 cfs (July 11, 1951) | 38,600 cfs (July 11, 1951) | 45,200 cfs (July 11, 1951) | 120,000 cfs (May 19, 1943) | 70,000 cfs (Aug 8, 1927) | 259,000 cfs (May 17, 1943) | Pomme de Terre, February 1985 (effective Mar 85) |
| Date of Closure | October 2, 1970 | July 19, 1962 | June 15, 1980 | September 23, 1968 | June 28, 1960 | July 21, 1977 | Harry S. Truman, April 1993 (effective Mar 94) |
| Date Storage Began | August 1, 1972 | October 18, 1963 | September 19, 1981 | December 12, 1969 | October 29, 1961 | February 7, 1979 | (4) The total drainage area above Truman Dam is 11,500 square miles. The indicated total is the local drainage area below the upstream dams. |
| Date Multipurpose Level Reached | April 4, 1975 | June 5, 1965 | February 23, 1985 | December 18, 1971 | June 15, 1963 | November 29, 1979 | (5) In 1994, 1000 AF of flood control storage at Truman Reservoir was reallocated to water supply. This is a nominal storage after allowances for sediment. Current water supply storage using the Mar 95 capacity tables is 1,023 AF. The top of the multipurpose pool was then adjusted from 706.0 to 706.018. Approximately 2/3 of the water supply space has been contracted to users. |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | 911.0 for concrete section | | | **TOTALS** |
| Top of Dam Elevation, feet msl | 1,078.0 | 1,031.0 | 952.2 | 912.0 for embankment | 906.0 | 756.0 | 417,619 ac |
| Length of Dam, feet (net) | 9,650 | 7,750 | 8,700 plus 3,300 dike | 5,100 plus 5,600 dike | 4,630 plus 2,790 dike | 5,000 plus 7,500 dike | 293,198 ac |
| Damming Height, feet (2) | 105 | 83 | 79 | 132 | 124 | 105 | 103,180 ac |
| Type of Fill | Earth | Earth | Earth | Rock Shell | Earth | Earth | 4,755,736 AF |
| Fill Quantity, cubic yards | 9,100,000 | 5,200,000 | 6,964,000 | 7,100,000 | 5,800,000 | 8,500,000 | 5,656,179 AF |
| **SPILLWAY** | | | | | | | 2,586,412 AF |
| Location | Left Abutment | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Center of Dam | 8,242,591 AF |
| Crest Elevation, feet msl | 1,057.0 | 1,006.0 | 935.0 | 861.5 | 874.0 | 692.3 | |
| Width, Feet | 200 | 200 | 50 | 160 | 170 | 160 | |
| Number, Size, and Type of Gates | None | None | None | 4 - 40’x30.5’ Tainter | None | 4 - 40’x47.3’ Tainter | |
| Discharge Capacity, Top of Surcharge Pool | 36,000 cfs | 50,300 cfs | 4,750 cfs | 182,500 cfs | 73,000 cfs | 284,000 cfs | |
| **RESERVOIR (3)** | | | | | | | |
| Surcharge Pool Elevation and Area | 1,073.0 ft msl 22,673 ac | 1,025.4 ft msl 14,584 ac | 948.0 ft msl 10,983 ac | 906.2 ft msl 48,053 ac | 900.2 ft msl 25,456 ac | 751.1 ft msl 295,870 ac | |
| Flood Control Pool Elevation and Area | 1,057.0 ft msl 13,935 ac | 1,003.0 ft msl 8,522 ac | 931.0 ft msl 7,413 ac | 892.0 ft msl 38,281 ac | 874.0 ft msl 15,999 ac | 739.6 ft msl 209,048 ac | |
| Multipurpose Pool Elevation and Area | 1,036.0 ft msl 6,912 ac | 974.0 ft msl 3,865 ac | 917.0 ft msl 4,575 ac | 867.0 ft msl 24,632 ac | 839.0 ft msl 7,790 ac | 706.02 ft msl (5) 55,406 ac | |
| Surcharge Storage, AF | 1,073.0 - 1,057.0 289,410 | 1,025.4 - 1,003.0 255,327 | 948.0 - 931.0 155,799 | 906.2 - 892.0 608,708 | 900.2 - 874.0 535,724 | 751.1 - 739.6 2,910,768 | |
| Flood Control Storage, AF | 1,057.0 - 1,036.0 208,207 | 1,003.0 - 974.0 176,123 | 931.0 - 917.0 83,570 | 892.0 - 867.0 776,066 | 874.0 - 839.0 406,821 | 739.6 - 706.02 4,005,392 | |
| Multipurpose Storage, AF | 1,036.0 - 965.0 152,051 | 974.0 - 930.0 64,208 | 917.0 - 852.5 76,270 | 867.0 - 765.0 874,887 | 839.0 - 750.0 237,356 | 706.02 - 631.0 1,181,640 | |
| Gross Storage, AF | 1,057.0 - 965.0 360,258 | 1,003.0 - 930.0 240,331 | 931.0 - 852.5 159,840 | 892.0 - 765.0 1,650,953 | 874.0 - 750.0 644,177 | 739.6 - 631.0 5,187,032 | |
| Design Sediment Reserve Storage | 26,000 AF for 100 years | 28,000 AF for 100 years | 11,000 AF for 100 years | 25,000 AF for 100 years | 13,000 AF for 50 years | 244,000 AF for 100 years | |
| Measured Sediment Inflow | 4,064 AF (1972 to 1985) | 7,045 AF (1963 to 1989) | 1,928 AF (1981 to 1993) | 8,953 AF (1969 to 1987) | 4,358 AF (1961 to 1974) | 22,321 AF (1979 to 1992) | |
| **OUTLET WORKS** | | | | | | | ac = acres |
| Location | Right Abutment | Right Abutment | Left Abutment | | Right Abutment | | AF = acre-feet |
| River Outlet Type | Gated Horseshoe Conduit | Gated Horseshoe Conduit | Gated Oblong Conduit | None | Gated Tunnel | None | ft = feet |
| Number and Size of Conduit | 1 - 11.5’ | 1 - 13.5’ | 1 - 15.92’x11.67’ | | 1 - 14’ | | msl = elevation above mean sea level |
| Length of Conduit, feet | 754 | 720.5 | 685 | | 560 | | cfs = cubic feet per second |
| Entrance Invert Elevation | 962.0 ft msl | 925.0 ft msl | 868.0 ft msl | | 750.0 ft msl | | kw = kilowatts |
| Discharge Capacity, Top of Surcharge Pool | 6,700 cfs | 9,200 cfs | 8,200 cfs | | 12,750 cfs | | hp = horsepower |
| Discharge Cap, Top of Flood Control Pool | 6,235 cfs | 8,170 cfs | 7,400 cfs | | 11,500 cfs | | |
| Discharge Cap, Top of Multipurpose Pool | 5,520 cfs | 6,400 cfs | 6,150 cfs | | 9,650 cfs | | |
| Service Gates, Number and Size | 2 - 6’x12’ | 2 - 6.5’x14’ | 2 - 5.33’x15.92’ | | 2 - 6.5’x14’ | | |
| Emergency Gates, Number and Size | 2 - 6’x12’ | 2 - 6.5’x14’ | 1 - 5.33’x15.92’ | | 1 - 6.5’x14’ | | |
| Low Flow Gates, Number and Size | 2 - 2’x2’ | 2 - 2’x2’ | 2 - 2’x2’ | 2 - 24” dia | 1 - 24” Butterfly | | Note: A portion of all multipurpose pools at lakes in the Osage River Basin have been contracted to the States and/or water supply districts for water supply uses. None have outlets specifically for water supply. Water supply quantities are either pumped from the lake or released into the river for downstream users through the regular outlet works. |
| Provision for Power | None | None | None | 3 - 20’x40’ | | 12 - 17’x26.5’ | |
| **POWER FACILITIES** | | | | | | | |
| Generator Turbine Units, Number | | | | 1 | | 6 | |
| Generator Name Plate Capacity, kw | | | | 45,200 | | 160,000 | |
| Turbine Rating, hp | | | | 75,600 (56 ft head) | | 254,400 | |
| Turbine Type | | | | Kaplan (Vertical Shaft) | | Kaplan (Inclined Shaft) | |
| Maximum (Full Pool) Head and Discharge | | | | 112 ft (6,300 cfs) | | 79.2 ft (31,800 cfs) | |
| Avg (Power & MP Pool) Head, Discharge | | | | 85 ft (7,900 cfs) | | 42.5 ft (65,000 cfs) | |
| Minimum Head and Discharge | | | | 62 ft (11,000 cfs) | | 41 ft (68,000 cfs) | |
| Reversible Pump Turbines | | | | None | | 6 | |
| Total Dynamic Head, feet | | | | | | 50 | |
| Discharge with 5 Units at Max Head, cfs | | | | | | 27,500 | |
| Maximum Power Required, hp | | | | | | 197,000 | |
| Maximum Drawdown, feet msl | | | | 845 | | 704 | |

**SUMMARY OF ENGINEERING DATA**
**OSAGE RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2002

Plate 2A

| SUBJECT | SMITHVILLE LAKE | LONGVIEW LAKE | BLUE SPRINGS LAKE | RATHBUN LAKE | LONG BRANCH LAKE | REMARKS |
|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Smithville, MO | Kansas City, MO | Kansas City, MO | Near Rathbun, IA | Near Macon, MO | (2) Damming height is from original riverbed to top of flood pool. |
| Stream / River | Little Platte River | Little Blue River | East Fork Little Blue River | Chariton River | East Fork Little Chariton River | (3) Based on latest available storage data. The revision dates of the current area capacity tables are indicated below with the effective dates in parentheses: |
| Miles above Mouth | 13.6 | 42.9 | 28.8 | 142.3 | 78 | Smithville Lake, February 1990 (effective March 1, 1990) |
| Contributing Drainage Area, square miles | 213 | 50.3 | 32.8 | 549 | 109 | Longview Lake, May 1970 (initial) |
| Approximate Length of Full Reservoir, miles | 18 | 3.5 | 2.5 | 14 | 9 | Blue Springs Lake, September 1974 (initial) |
| Shoreline, miles (1) | 175 | 24 | 12 | 155 | 24.2 | Rathbun Lake, January 2000 (effective December 1, 2000) |
| Maximum Discharge of Record near Dam Site | 76,600 cfs (July 20, 1965) | 18,700 cfs (August 13, 1982) | 11,000 cfs (August 13, 1982) | 21,800 cfs (March 31, 1960) | 30,000 cfs (April 21, 1973) | Long Branch Lake, January 1989 (effective July 1, 1989) |
| Date of Closure | July 13, 1976 | June 16, 1983 | August 12, 1986 | September 29, 1967 | September 3, 1976 | (4) Spillway flood routing at Long Branch Lake revised for Emergency Action Plan, dated 1981. |
| Date Storage Began | October 19, 1979 | September 16, 1985 | September 27, 1988 | November 21, 1969 | August 2, 1978 | (5) The Rathbun outlet works cannot discharge more than 1,800 cfs without special approval from the Water Mgmt office. Flows above 1,800 cfs result in overtopping of the outlet works stilling basin walls. |
| Date Multipurpose Level Reached | June 11, 1982 | September 23, 1986 | March 18, 1990 | October 10, 1970 | May 19, 1981 | |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | | | |
| Top of Dam Elevation, feet msl | 895.0 | 926.6 | 840.0 | 946.0 | 826.0 | |
| Length of Dam, feet (net) | 4,000 | 1,900 | 2,500 | 10,600 | 3,550 | |
| Damming Height, feet (2) | 80.2 | 110 | 70 | 82 | 71 | |
| Type of Fill | Rolled Earth | Earth | Earth and Rock | Rolled Earth | Rolled Earth | |
| Fill Quantity, cubic yards | 3,200,000 | 2,500,000 | 1,200,000 | 4,700,000 | 1,855,000 | |
| **SPILLWAY** | | | | | | |
| Location | Right Abutment | Left Abutment | Left Abutment | Right Abutment | Right Abutment | |
| Crest Elevation, feet msl | 880.2 | 911.3 | 823.6 | 926.0 | 809.0 | |
| Width, feet | 50 | 200 | 300 | 500 | 50 | |
| Number, Size, and Type of Gates | None | None | None | None | None | |
| Discharge Capacity, Top of Surcharge Pool | 4,800 cfs | 22,970 cfs | 37,800 cfs | 45,600 cfs | 9,860 cfs (4) | |
| **RESERVOIR (3)** | | | | | | **TOTALS** |
| Surcharge Pool Elevation and Area | 891.1 ft msl 14,611 ac | 922.9 ft msl 3,207 ac | 837.7 ft msl 1,200 ac | 940.0 ft msl 31,135 ac | 821.2 ft msl 6,608 ac (4) | 56,761 ac |
| Flood Control Pool Elevation and Area | 876.2 ft msl 9,990 ac | 909.0 ft msl 1,964 ac | 820.3 ft msl 982 ac | 926.0 ft msl 22,452 ac | 801.0 ft msl 3,663 ac | 39,051 ac |
| Multipurpose Pool Elevation and Area | 864.2 ft msl 7,115 ac | 891.0 ft msl 927 ac | 802.0 ft msl 722 ac | 904.0 ft msl 10,329 ac | 791.0 ft msl 2,429 ac | 21,522 ac |
| Recreation Pool Elevation and Area | | 870.0 ft msl 432 ac | | | | 432 ac |
| Surcharge Storage | 891.1 - 876.2 182,198 AF | 922.9 - 909.0 35,370 AF | 837.7 - 820.3 19,039 AF | 940.0 - 926.0 368,859 AF | 821.2 - 801.0 101,880 AF (4) | 707,346 AF |
| Flood Control Storage | 876.2 - 864.2 101,777 AF | 909.0 - 891.0 24,810 AF | 820.3 - 802.0 15,715 AF | 926.0 - 904.0 349,173 AF | 801.0 - 791.0 30,327 AF | 521,802 AF |
| Multipurpose Storage | 864.2 - 810.0 141,666 AF | 891.0 - 870.0 13,579 AF | 802.0 - 760.0 10,842 AF | 904.0 - 857.0 221,360 AF | 791.0 - 750.0 34,189 AF | 421,636 AF |
| Recreation Storage | | 870.0 - 810.0 8,555 AF | | | | 8,555 AF |
| Gross Storage | 876.2 - 810.0 243,443 AF | 909.0 - 810.0 46,944 AF | 820.3 - 760.0 26,557 AF | 926.0 - 857.0 570,533 AF | 801.0 - 750.0 64,516 AF | 951,993 AF |
| Design Sediment Reserve Storage | 52,300 AF for 100 years | 2,000 AF for 100 years | 300 AF for 100 years | 24,000 AF for 100 years | 4,000 AF for 100 years | |
| Measured Sediment Inflow | 4,987 AF (1979 to 1993) | 20 AF/year (estimated) | 3 AF/year (estimated) | 240 AF/year (estimated) | 483 AF (1978 to 1988) | |
| **OUTLET WORKS** | | | | | | |
| Location | Right Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | |
| River Outlet Type | Rectangular Conduit | Concrete Arch | Arch Conduit | Horseshoe Conduit | Concrete Arch | |
| Number and Size of Conduit | 1 - 8’x9’ | 1 - 5.5’x5’ | 1 - 3.5’x4.75’ | 1 - 11’ | 1 - 6’x5.5’ | |
| Length of Conduit, feet | 696 | 916 | 485 | 539 | 450 | |
| Entrance Invert Elevation | 805.0 ft msl | 816.0 ft msl | 768.5 ft msl | 855.0 ft msl | 760.0 ft msl | |
| Drop Inlet Crest Elevation | | 891 | 802.0 ft msl | | | |
| Low Flow Gate Intake Elevation | | 875 - 861 | 791.5 | | | |
| Discharge Cap, Top Flood Control Pool | 3,150 cfs | 1,200 cfs | 570 cfs | 5,160 cfs (5) | 910 cfs | |
| Discharge Cap, Top of Multipurpose Pool | 2,940 cfs | 0 (except low flow outlets) | 0 (except low flow outlets) | 4,220 cfs (5) | 495 cfs | |
| Service Gates, Number and Size | 2 - 4.25’x9.25’ Slide | | | 2 - 6’x12’ Slide | 2 - 24” Slide | |
| Emergency Gates, Number and Size | 2 - 4.25’x9.25’ Slide | 1 - 6’x7’ | 1-4.5’x5’ | 2 - 6’x12’ Slide | 1 - 6’x6’ | |
| Low Flow Gates, Number, Size, Type | | 2 - 24” Knife Valves | 1-2’ Knife Valve | | | |
| Low Flow Gates, Number and Size | 1 - 2’x2’ | 2 - 24” Knife Valves | 1-2’ Knife Valve | 2 - 2’ x2’ Slide | 1 - 18” Slide | |
| Provision for Power | None | None | None | None | None | |
| Provision for Water Supply | 1 - 5.75’ Pipe<br>A portion of MP storage contracted to water supply users, pumped from pool. | None | None | No pipe outlets, but water supply contracts exist with water district provided by releases to river. | No pipe outlets, but water supply contracts in effect to use a portion of MP storage, pumped from pool. | |

ac = acres
AF = acre-feet
ft = feet
msl = elevation above mean sea level
cfs = cubic feet per second

**SUMMARY OF ENGINEERING DATA**
**LOWER MISSOURI RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City Distict
December 2002

Plate 2B

| SUBJECT | MILFORD LAKE | TUTTLE CREEK LAKE | PERRY LAKE | CLINTON LAKE | REMARKS |
|---|---|---|---|---|---|
| **GENERAL** | | | | | (1) With pool at multipurpose level. |
| Location of Dam | Near Junction City, KS | Near Manhatten, KS | Near Perry, KS | Near Lawrence, KS | (2) Damming height is from the original riverbed to the top of the flood control pool. |
| Stream / River | Republican River | Big Blue River | Delaware River | Wakanusa River | (3) Based on latest available storage data. The revision dates of the current |
| Miles above Mouth | 7.7 | 10 | 5.3 | 22.2 | area - capacity tables are indicated below with the effective dates in parentheses: |
| Contributing Drainage Area, square miles | 17,388 (4) | 9,628 | 1,117 | 367 | Milford Lake, March 1982 (effective March 10, 1982) |
| Approximate Length of Full Reservoir, miles | 30 | 50 | 20 | 17 | Tuttle Creek Lake, October 2000 (effective February 1, 2001) |
| Shoreline, miles (1) | 163 | 112 | 160 | 82 | Perry Lake, May 1990 (effective June 1, 1990) |
| Maximum Discharge of Record near Dam Site | 171,000 cfs (June 3, 1935) | 98,000 cfs (June 1951) | 94,600 cfs (June 1951) | 24,200 cfs (July 1951) | Clinton Lake, December 1991 (effective March 1, 1994) |
| Date of Closure | August 24, 1964 | July 20, 1959 | August 2, 1966 | August 23, 1975 | (4) Total drainage area above Milford is 38,621 square miles. The indicated total is |
| Date Storage Began | January 16, 1967 | March 7, 1962 | January 15, 1969 | November 30, 1977 | the local drainage area below Harlan County Dam. |
| Date Multipurpose Level Reached | July 14, 1967 | April 29, 1963 | June 3, 1970 | April 3, 1980 | |
| Operating Agency | Corps of Engineers | Corps of Engineers | Corps of Engineers | Corps of Engineers | |
| **DAM AND EMBANKMENT** | | | | | ac = acres |
| Top of Dam Elevation, feet msl | 1,213.0 | 1,159.0 | 946.0 | 928.0 | AF = acre-feet |
| Length of Dam, feet (net) | 6,300 | 7,487 | 7,750 | 9,250 | ft = feet |
| Damming Height, feet (2) | 110.2 | 134 | 95 | 114 | msl = elevation above mean sea level |
| Type of Fill | Earth | Earth, Rock | Earth | Earth | cfs = cubic feet per second |
| Fill Quantity, cubic yards | 15,000,000 | 21,000,000 | 8,000,000 | 10,423,000 | |
| **SPILLWAY** | | | | | |
| Location | Right Abutment | Left Abutment | Left Abutment | Left Abutment | |
| Crest Elevation, feet msl | 1,176.2 | 1,116.0 | 922.0 | 907.4 | |
| Width, feet | 1,250 | 1,059 | 300 | 500 | |
| Number, Size, and Type of Gates | None | 18 - 40’x20’ Tainter | None | None | |
| Discharge Capacity, Top of Surcharge Pool | 560,000 cfs | 579,000 cfs | 65,000 cfs | 44,200 cfs | |
| **RESERVOIR (3)** | | | | | **TOTALS** |
| Surcharge Pool Elevation and Area | 1,208.2 ft msl 59,886 ac | 1,151.4 ft msl 70,030 ac | 941.2 ft msl 42,656 ac | 921.4 ft msl 18,336 ac | 190,908 ac |
| Flood Control Pool Elevation and Area | 1,176.2 ft msl 32,979 ac | 1,136.0 ft msl 53,050 ac | 920.6 ft msl 25,363 ac | 903.4 ft msl 12,890 ac | 124,282 ac |
| Multipurpose Pool Elevation and Area | 1,144.4 ft msl 15,709 ac | 1,075.0 ft msl 12,617 ac | 891.5 ft msl 11,146 ac | 875.5 ft msl 7,120 ac | 46,592 ac |
| Surcharge Storage | 1,208.2 - 1,176.2 1,442,049 AF | 1,151.4 - 1,136.0 939,272 AF | 941.2 - 920.6 692,375 AF | 921.4 - 903.4 285,809 AF | 3,359,505 AF |
| Flood Control Storage | 1,176.2 - 1,144.4 756,669 AF | 1,136.0 - 1,075.0 1,870,735 AF | 920.6 - 891.5 515,795 AF | 903.4 - 875.5 268,783 AF | 3,411,982 AF |
| Multipurpose Storage | 1,144.4 - 1,080.0 388,816 AF | 1,075.0 - 1,020.0 280,137 AF | 891.5 - 835.0 209,513 AF | 875.5 - 828.0 125,334 AF | 1,003,800 AF |
| Gross Storage | 1,176.2 - 1,080.0 1,145,485 AF | 1,136.0 - 1,020.0 2,150,872 AF | 920.6 - 835.0 725,308 AF | 903.4 - 828.0 394,117 AF | 4,415,782 AF |
| Design Sediment Reserve Storage | 160,000 AF for 100 years | 240,312 AF for 50 years | 140,000 AF for 100 years | 28,500 AF for 100 years | |
| Measured Sediment Inflow | 47,935 AF (1967 to 1994) | 216,145 AF (1962 to 2000) | 49,057 AF (1969 to 1993) | 3,421 AF (1977 to 1991) | |
| **OUTLET WORKS** | | | | | |
| Location | Right Abutment | Right Abutment | Near Center of Dam | Left Abutment | |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | |
| Number and Size of Conduit | 1 - 21’ | 2 - 20’ | 1 - 23.5’ | 1 - 12.5’x13’ Arch | |
| Length of Conduit, feet | 615.5 | 860 | 592 | 710 | |
| Entrance Invert Elevation | 1,080.0 ft msl | 1,003.0 ft msl | 833.0 ft msl | 828.0 ft msl | |
| Gated Sluice, Number and Size | None | None | None | None | |
| Discharge Cap, Top of Flood Control Pool | 23,100 cfs | 45,900 cfs | 27,500 cfs | 7,570 cfs | |
| Discharge Cap, Top of Multipurpose Pool | 18,600 cfs | 31,300 cfs | 21,200 cfs | 5,900 cfs | |
| Service Gates, Number and Size | 2 - 10.5’x21’ | 4 - 10’x20’ | 2 - 11.75’x23.5’ | 2 - 6.33’x12.67’ | |
| Emergency Gates, Number and Size | 2 - 10.5’x21’ | 1 - 10’x20’ | 2 - 11.75’x23.5’ | 1 - 6.33’x12.67’ | |
| Low Flow Gates, Number and Size | 2 - 2’x2’ | 2 - 24” Butterfly Valve | 2 - 2’x2’ | 1 - 24” Knife Gate Value | |
| Water Supply Gate, Number and Size | None | None | None | 1 - 54”x54” Slide Gate | |
| Provision for Irrigation | None | None | None | None | |
| Provision for Power | None | None | None | None | |
| Provision for Water Supply | No structural provisions, but MP pool contracted to State for water supply, provided by releases to river. At this time 33.9% has been placed into service, or 101,650 AF after allowances for sediment. Current in-service storage is 131,744 AF. Remaining 257,072 AF of MP storage is reserved by State. | No structural provisions, but part of MP pool contracted to State for water supply, provided by releases to river. At this time, 100% has been placed into service, or 50,000 AF after allowances for sediment. Current in-service storage is 114,810 AF. Remaining 165,317 AF of MP storage is reserved by Corps for other MP purposes including water quality releases and navigation flow supplementation. | No structural provisions, but MP pool contracted to State for water supply, provided by releases to river. At this time 16.7% has been placed into service, or 25,000 AF after allowances for sediment. Current in-service storage is 34,919 AF. Remaining 174,594 AF of MP storage is reserved by State. | 36” Steel Pipe Many water supply contracts with State and individual water districts utilizing the entire allocated water supply of 101,266 AF (89,200 AF after allowances for sediment). Remaining allocation of 24,068 AF (21,200 AF after allowances for sediment) reserved to provide water quality (minimum flow) releases. | |

**SUMMARY OF ENGINEERING DATA**
**LOWER KANSAS RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2002

Plate 2C

| SUBJECT | BONNY RESERVOIR | SWANSON LAKE | ENDERS RESERVOIR | HUGH BUTLER LAKE | HARRY STRUNK LAKE | KEITH SEBELIUS LAKE (Norton Dam) | HARLAN COUNTY LAKE | LOVEWELL RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | | | (1) With pool at MP level. |
| Location of Dam | Near Hale, CO | Near Trenten, NE | Near Enders, NE | Near McCook, NE | Near Cambridge, NE | Near Norton, KS | Nr Republican City, NE | Near Lovewell, KS | (2) Damming height is |
| Stream / River | S. Fk Republican River | Republican River | Frenchman Creek | Red Willow Creek | Medicine Creek | Prairie Dog Creek | Republican River | White Rock Creek | from original riverbed to |
| Miles above Mouth | 60.4 | 359 | 81.7 | 18.7 | 11.9 | 74.9 | 232.3 | 19.3 | top of flood control pool. |
| Contributing Drainage Area, sq mi | 1,435 | 2,506 below Bonny | 786 | 310 | 642 | 688 | 7,169 below u/s dams (5) | 358 | (3) Based on latest storage |
| Approx Length of Full Resv, miles | 5.5 | 9.0 | 6.0 | 7.5 | 8.5 | 9.5 | 17 | 11 | data. Date of current area |
| Shoreline, miles (1) | 15.0 | 30 | 26 | 35 | 29 | 32 | 54 | 44 | capacity tables given below |
| Max. Disch. of Record nr Dam Site | 103,000 (May 31, 1935) | 200,000 (May 31, 1935) | Insufficient Data | 30,000 (June 22, 1947) | 120,000 (June 1947) | 37,500 (May 28, 1953) | 260,000 (June 1, 1935) | 23,300 (July 10, 1950) | with effective date in ( ). |
| Date of Closure | July 6, 1950 | May 4, 1953 | October 23, 1950 | September 5, 1961 | August 8, 1949 | January 28, 1964 | July 22, 1951 | May 29, 1957 | Bonny, Mar 51 (initial) |
| Date Storage Began | July 6, 1950 | May 4, 1953 | October 23, 1950 | September 5, 1961 | August 8, 1949 | October 5, 1964 | November 14, 1952 | October 2, 1957 | Swanson, Feb 84 (Jan 84) |
| Date Multipurpose Level Reached | March 19, 1954 | May 15, 1957 | January 29, 1952 | May 21, 1967 | April 2, 1951 | June 21, 1967 | June 14, 1957 | May 20, 1958 | Enders, May 97 (Jan 1, 99) |
| Operating Agency | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Corps of Engineers | Bureau of Reclamation | Butler, May 97 (Jan 1, 99) |
| **DAM AND EMBANKMENT** | | | | | | | | | Strunk, Oct 82 (Feb 1, 83) |
| Top of Dam Elevation, feet msl | 3,742.0 | 2,793.0 | 3,137.5 | 2,634.0 | 2,415.0 | 2,347.0 | 1,982.0 | 1,616.0 | Sebelius, Sep 00 (Jan 02) |
| Length of Dam, feet (Less Spillway) | 9,141.5 | 8,600 | 2,242 | 3,159 | 5,665 | 6,344 | 11,830 | 8,392 | Harlan, Jan 01 (Jan 1, 01) |
| Damming Height, feet (2) | 93.0 | 80.0 | 93.0 | About 85 | 86 | 85.5 | 98.5 | 70.3 | Lovewell, Jun 95 (Jan 97) |
| Type of Fill | Earth | Earth | Earth | Earth | Earth | Earth | Earth | Earth | (4) Bartley Div Dam, Rep |
| Fill Quantity, cubic yards | 8,853,000 | 8,130,000 | 1,950,000 | 3,122,000 | 2,730,000 | 3,740,000 | 13,400,000 | 3,000,000 | R. below Red Willow Ck, |
| **SPILLWAY** | | | | | | | | | conc ogee weir w/2-10x16 |
| Location | Left Abutment | Left Abutment | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Center of Dam | Right Abutment | gates to rivr, 2-10'x3' gates |
| Crest Elevation, feet msl | 3,710.0 | 2,743.0 | 3,097.0 | 2,604.9 | 2,386.2 (see also below) | 2,296.0 | 1,943.5 | 1,575.3 | to canal, max cap 130 cfs. |
| Width, feet | 121.5 | 142 | 361 | 31.5 (circ morning glory) | 229 | 106 | 856 | 53 | Franklin pumps on Rep R. |
| Number, Size, and Type of Gates | None (see notes below) | 3 - 42' x 30' Radial | 6 - 50' x 30' Radial | None | None | 3 - 30'x36.35' Radial | 18 - 40'x30' Radial | 2 - 25'x20' Radial | blw Harlan Cty, cap 40 cfs. |
| Disch. Cap. Top of Surcharge Pool | 73,300 cfs (with sluice) | 126,000 cfs | 202,000 cfs (with notch) | 4,910 cfs | 99,000 cfs (with notch) | 96,000 cfs | 480,000 cfs | 35,000 cfs | Courtland Div Dam, Rep R |
| **RESERVOIR (3)** | | | | | | | | | **TOTALS** |
| Surcharge Pool Elev (ft msl), Area | 3,736.2 8,579 ac | 2,785.0 10,035 ac | 3,129.5 ft msl 2,557 ac | 2,628.0 ft msl 4,079 ac | 2,408.9 ft msl 5,784 ac | 2,341.0 ft msl 6,713 ac | 1,975.5 ft msl 24,339 ac | 1,610.3 ft msl 7,635 ac | 69,721 ac |
| Flood Cntrl Pool Elev (ft msl), Area | 3,710.0 5,036 ac | 2,773.0 7,940 ac | 3,127.0 ft msl 2,405 ac | 2,604.9 ft msl 2,681 ac | 2,386.2 ft msl 3,483 ac | 2,331.4 ft msl 5,316 ac | 1,973.5 ft msl 23,431 ac | 1,595.3 ft msl 5,024 ac | 55,316 ac |
| MP, or Top Cons Pool Elev, Area | 3,672.0 2,042 ac | 2,752.0 4,922 ac | 3,112.3 ft msl 1,707 ac | 2,581.8 ft msl 1,621 ac | 2,366.1 ft msl 1,840 ac | 2,304.3 ft msl 2,181 ac | 1,945.73 msl 13,305 ac | 1,582.6 ft msl 2,987 ac | 30,605 ac |
| Inactive Pool Elev (ft msl), Area | 3,638.0 331 ac | 2,720.0 1,411 ac | 3,082.4 ft msl 627 ac | 2,558.0 ft msl 715 ac | 2,343.0 ft msl 701 ac | 2,280.4 ft msl 575 ac | 1,932.5 ft msl 9,282 ac | 1,571.7 ft msl 1,495 ac | 15,137 ac |
| Dead Stor Pool Elev (ft msl), Area | 3,635.5 242 ac | 2,710.0 488 ac | 3,080.0 ft msl 567 ac | 2,552.0 ft msl 536 ac | 2,335.0 ft msl 481 ac | 2,275.0 ft msl 317 ac | 1,885.0 ft msl 0 ac | 1,562.07 ft msl 494 ac | 3,125 ac |
| Surcharge Storage, AF | 3,736.2 - 3,710 178,230 | 2,785 - 2,773 107,610 | 3,129.5 - 3,127 6,203 | 2,628.0 - 2,604.9 76,829 | 2,408.9 - 2,386.2 105660 | 2,341.0 - 2,331.4 58,287 | 1,975.5 - 1,973.5 47,767 | 1,610.3 - 1,595.3 94,145 | 674,731 AF |
| Flood Control Storage, AF | 3,710.0 - 3,672 128,820 | 2,773 - 2,752 134,077 | 3,127.0 - 3,112.3 30,048 | 2,604.9 - 2,581.8 48,846 | 2,386.2-2,366.1 52,715 | 2,331.4 - 2,304.3 99,230 | 1,973.5 - 45.73 500,000 | 1,595.3 - 1,582.6 50,465 | 1,044,201 AF |
| MP, or Active Conserv Storage, AF | 3,672.0 - 3,638 39,206 | 2,752 - 2,720 99,784 | 3,112.3 - 3,082.4 33,962 | 2,581.8 - 2,558 27,303 | 2,366.1 - 2,343 26,846 | 2,304.3 - 2,280.4 30,517 | 1,945.73 - 32.5 150,000 | 1,582.6 - 1,571.7 24,022 | 431,640 AF |
| Inactive Storage, AF | 3,638.0 - 3,635.5 716 | 2,720 - 2,710 10,312 | 3,082.4 - 3,080 1,432 | 2,558.0 - 2,552 3,736 | 2,343.0 - 2,335 4,699 | 2,280.4 - 2,275 2,357 | 1,932.5 - 1,890 164,111 | 1,571.7 - 1,562.07 9,985 | 197,348 AF |
| Dead Storage, AF | 3,635.5 - 3,617 1,418 | 2,710 - 2,701 2,118 | 3,080.0 - 3,050 7,516 | 2,552.0 - 2,527 5,185 | 2,335.0 - 2,318.5 4,160 | 2,275.0 - 2,262 1,636 | Sluice crest at 1,885 0 | 1,562.07 - 1,550.0 1,659 | 23,692 AF |
| Gross Storage, AF | 3,710.0 - 3,617 170,160 | 2,773 - 2,701 246,291 | 3,127.0 - 3,050 72,958 | 2,604.9 - 2,527 85,070 | 2,386.2 - 2,318.5 88,420 | 2,331.4 - 2,262 133,740 | 1,973.5 - 1,890 814,111 | 1,595.3 - 1,550.0 86,131 | 1,696,881 AF |
| Design Sediment Reserve Storage | 8,000 AF for 50 years | 51,000 AF for 50 years | 4,000 AF for 100 years | 10,000 AF for 50 years | 15,000 AF for 50 years | 6,000 AF for 50 years | 200,000 AF for 100 yrs | 8,000 AF for 50 years | |
| Measured Sediment Inflow | 160 AF/year (estimated) | 7,659 AF (1953 to 1982) | 1,572 AF (1950 to 1997) | 1,616AF (1961 to 1997) | 4,397 AF (1949 to 1981) | 1,617 AF (1964 to 2000) | 38,548 AF (1952 - 00) | 6,021 AF (1957 to 1995) | |
| **OUTLET WORKS** | | | | | | | | | at Guide Rock, conc ogee |
| Location | Left Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | Left Abutment | Center of Dam | Right Abutment | w/2-20'x12' gates to river |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Sluices | Spillway gates used for | 5-10'x6'gates to Courtland |
| Number and Size of Conduit | 1 – 56" Cond to 26" Pipe | 2 - 6' x 7.5' | 1 - 84" Cond to 84"Pipe | 1 - 82" | 1 – 84" Cond to 44" Pipe | 1 – 48" Cond to 38" Pipe | 9 - 5'x8' thru Spillway | river releases. Gated | canal (cap 751 cfs), 1-10x6 |
| Length of Conduit, feet | 831.5 | 86.74 | 516 | 553.5 | 553 | 495 to Gate, 145 to Basin | | wasteway with 1-10'x9' | gate to Superior (cap 139). |
| Entrance Crest Elevation | 3,635.5 ft msl | 2,710.0 ft msl | 3,080.0 ft msl | 2,552.0 ft msl | 2,335.0 ft msl | 2,275.0 ft msl | 1,885.0 ft msl | radial gate from outlet | Other private diversion |
| Disch Cap, Top of Flood Cntrl Pool | 140 cfs (approx) | 4,300 cfs | 1,430 cfs | 1,170 cfs | 398 cfs (max elev 2,379) | 312 cfs | 20,700 cfs | canal to stilling basin. | weirs exist on some creeks |
| Disch Cap, Top of MP (Consv) Pool | 103 cfs | 3,500 cfs | 1,300 cfs | 990 cfs | 361 cfs | 257 cfs | 17,370 cfs | Wasteway is not used. | like Riverside blw Enders |
| Service Gates, Number, Size, Type | 1 - 24" Hollow Jet Valve | 2 - 6' x 7.5' Slide Gates | 2-60" Hollow Jet Valves | 2 - 42" Slide Gates | 1 – 39" Slide Gate | 1 - 33" Slide Gate | 9 - 5' x 8' Slide Gates | None | but div capacity minimal. |
| Provision for Irrigation | 1 - 32" Pipe to 24" Valve | 1 - 56" Pipe to 4' Gate | None | None | None | None | 1-5.5'; 1-2.83' Conduits | 1 - 8'x10' Gated Outlet | (5) 13,536 sq mi total |
| Provision for Power | Note: Storage owned by | None | None | None | None | None | 12'x12' Plug for 9' Cond | None | contributing with u/s dams. |
| Provision for Municipal Supply | CO for F&W, Recreation | None | None | None | None | 1 - 16" Pipe to 16" Gate | None | None | ac = acres ft = feet |
| Other Outlet | 1 - 40" Capped Conduit | None | None | None | None | None | Notes: 2001 revision to | Note: Inflow to lake also | AF = acre-feet |
| | | | | | | | Water Control Manual | provided from gated | cfs = cubic feet per sec |
| | Notes: Spillway also has 16.5'x21.5' sluice, with 1 - 16.5' x 10.75'gate, crest elev 3,672.0. The 56" gated outlet conduit feeds all three gated sub outlets. Capacity of irrig pipe outlet limited to 34.5 cfs by canal cap. | Notes: Irrigation outlet in right abutment. River outlets must be closed at pool elevations above 2,773.0. | Notes: Spillway also has an uncontrolled notch w/ crest elevation at 3112.3. Concrete ogee weir diversion dam 52 miles d/s, w/ 2-14' x 9.5' gates plus 30" gated condut to river, and 2- 10'x6' gates to canal (cap 400 cfs). | Note: Concrete ogee weir diversion dam 13 miles downstream, w/ 1-6'x18' radial gate to river, and 2 - 5'x4' regulating gates to canal (max cap 90 cfs) Bartley Diversion Dam located below Rep. R. confluence. See note (4) | Notes: Spillway also has an uncontrolled notch w/ crest elevation at 2366.1. Concrete ogee weir div-ersion dam at mile 301.6 on Rep. R. blw Med Ck. 2-10'x14'gates to river and 4-10'x14' gates to canal (max cap 325 cfs). | Notes: Concrete ogee weir diversion dam 17.6 miles downstream, with 1 – 6'x18' radial gate to river, 2 – 6'x5' gates to Main Canal (cap 100 cfs) and 2 – 5'x4' gates to South Canal (capacity 36 cfs). | allows drawdown to elev 1927 in extreme drought. 1-18" outlet for low flow regulation in mono 20. Franklin Canal conduit to 2-36" gates, cap 520 cfs. Naponee Canal conduit to 1-24" valve, cap 40 cfs. See also note (4) | Courtland Canal outlet. | msl = elev abv mean sea lvl |

**SUMMARY OF ENGINEERING DATA**
**REPUBLICAN RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2002

Plate 2D

| SUBJECT | WACONDA LAKE | KIRWIN RESERVOIR | WEBSTER RESERVOIR | WILSON LAKE | KANOPOLIS LAKE | CEDAR BLUFF RESERVOIR | REMARKS |
|---|---|---|---|---|---|---|---|
| **GENERAL** | | | | | | | (1) With pool at multipurpose or full conservation level. |
| Location of Dam | Near Glen Elder, KS | Near Kirwin, KS | Near Stockton, KS | Near Wilson, KS | Near Ellsworth, KS | Near Ellis, KS | (2) Damming height is height from original river bed to top of flood control pool. |
| Stream / River | Solomon River | North Fork Solomon River | South Fork Solomon River | Saline River | Smoky Hill River | Smoky Hill River | (3) Based on latest available storage data. The dates of the current area - capacity tables are indicated below along with the effective dates in parenthesis: |
| Miles above Mouth | 172.4 | 67.8 | 92.4 | 153.9 | 183.7 | 333.4 | Waconda, July 2001 (effective January 1, 2003) |
| Contributing Drainage Area, sq miles | 2,559 below u/s dams (4) | 1,367 | 1,150 | 1,917 | 2,330 blw Cedar Bluff (6) | 5,365 | Kirwin, May 1996 (effective January 1, 1998) |
| Approx Length of Full Reservoir, miles (1) | 24 | 9 | 7 | 24 | 12 | 9 | Webster, May 1996 (effective January 1, 1998) |
| Shoreline, miles (1) | 100 | 37 | 27 | 100 | 41 | 50 | Wilson, December 1984 (effective January 1, 1985) |
| Maximum Discharge of Record nr Dam Site | 125,000 cfs (July 1951) | 24,000 cfs (Sep 1919) | 55,200 cfs (July 1951) | 25,700 cfs (Jul-Aug 1928) | 61,000 cfs (June 1938) | 98,000 cfs (May 1938) | Kanopolis, February 1983 (effective March 1, 1983) |
| Date of Closure | October 18, 1967 | March 7, 1955 | May 3, 1956 | September 3, 1963 | July 26, 1946 | November 13, 1950 | Cedar Bluff, March 2001 (effective January 1, 2002) |
| Date Storage Began | July 24, 1968 | October 5, 1955 | May 3, 1956 | December 29, 1964 | February 17, 1948 | November 13, 1950 | (4) Total DA with Kirwin and Webster = 5,076 sq miles |
| Date Multipurpose Level Reached | May 16, 1973 | July 2, 1957 | June 18, 1957 | March 12, 1973 | July 19, 1948 | June 21, 1951 | (5) 7’ conduit from intake tower to gate chamber. 4’x5’ emergency gate to 60” pipe. Entrance to stilling well controlled by 4’x5’ slide gate. From stilling well, 42” river outlet pipe controlled by 36” gate. River outlet capacity at top of MP pool and flood control pool about 220 cfs. Length of combined pipes from intake to stilling well about 500’. About 200’ more to stilling basin. Canal releases from two openings at top of stilling well. Canal capacity is about 175 cfs, but combined capacity with river outlet about 395 cfs. |
| Operating Agency | Bureau of Reclamation | Bureau of Reclamation | Bureau of Reclamation | Corps of Engineers | Corps of Engineers | Bureau of Reclamation | (6) Total contrib. DA with Cedar Bluff = 7,695 sq miles |
| **DAM AND EMBANKMENT** | | | | | | | |
| Top of Dam Elevation, feet msl | 1,500.0 | 1,779.0 | 1,944.0 | 1,592.0 | 1,537.0 | 2,198.0 | |
| Length of Dam, feet (Less Spillway) | 14,631 | 12,246 | 10,604 | 5,600 | 15,360 | 12,409.5 | |
| Damming Height, feet (2) | 107.9 | 95 | 84.7 | 114 | 102 | 102 | |
| Type of Fill | Earth | Earth | Earth | Earth | Earth | Earth | |
| Fill Quantity, cubic yards | 8,050,000 | 9,537,000 | 8,145,000 | 8,500,000 | 15,200,000 | 8,490,000 | |
| **SPILLWAY** | | | | | | | |
| Location | Right Abutment | Right Abutment | Left Abutment | Right Abutment | Right Abutment | Right Abutment | |
| Crest Elevation, feet msl | 1,467.4 | 1,757.3 | 1,884.6 | 1,582.0 | 1,507.0 | 2,166.0 | |
| Width, feet | 644 | 400 (uncontrolled) | 116 | 450 (uncontrolled) | 500 (uncontrolled) | 150.5 (uncontrolled length) | |
| Number, Size, and Type of Gates | 12 - 50’x21.76’ Radial | None, but see note below | 3 – 33.33’x39.51’ Radial | None | None | Gated orifice, see note blw | |
| Discharge Capacity at Top of Surcharge Pool | 278,000 cfs | 96,000 cfs (sluices closed) | 138,000 cfs | 15,700 cfs | 172,000 cfs | 84,000 cfs (with orifice) | |
| **RESERVOIR (3)** | | | | | | | **TOTALS** |
| Surcharge Pool Elevation (ft msl), Area | 1,492.9 ft msl 38,178 ac | 1,773.0 ft msl 14,660 ac | 1,938.0 ft msl 11,270 ac | 1,587.5 ft msl 33,882 ac | 1,531.8 ft msl 23,408 ac | 2,192.0 ft msl 16,510 ac | 137,908 ac |
| Flood Control Pool Elevation (ft msl), Area | 1,488.3 ft msl 33,682 ac | 1,757.3 ft msl 10,639 ac | 1,923.7 ft msl 8,478 ac | 1,554.0 ft msl 20,027 ac | 1,508.0 ft msl 13,958 ac | 2,166.0 ft msl 10,790 ac | 97,574 ac |
| Multipurpose, or Top Cons Pool Elev, Area | 1,455.6 ft msl 12,602 ac | 1,729.25 ft msl 5,071 ac | 1,892.45 ft msl 3,767 ac | 1,516.0 ft msl 9,045 ac | 1,463.0 ft msl 3,406 ac | 2,144.0 ft msl 6,869 ac | 40,760 ac |
| Inactive Pool Elevation (ft msl), Area | 1,428.0 ft msl 3,020 ac | 1,697.0 ft msl 1,006 ac | 1,860.0 ft msl 904 ac | | | 2,107.8 ft msl 1,907 ac | |
| Dead Storage Pool Elevation (ft msl), Area | 1,407.8 ft msl 248 ac | 1,693.0 ft msl 765 ac | 1,855.5 ft msl 440 ac | | | 2,090.0 ft msl 755 ac | |
| Surcharge Storage, AF | 1,492.9 - 1,488.3 203,798 | 1,773.0 - 1,757.3 198,467 | 1,938.0 - 1,923.7 140,912 | 1,587.5 - 1,554.0 894,263 | 1,531.8 - 1,508.0 438,655 | 2,192.0 - 2,166.0 353,250 | 2,229,345 AF |
| Flood Control Storage, AF | 1,488.3 - 1,455.6 722,988 | 1,757.3 - 1,729.25 215,136 | 1,923.7 - 1,892.45 183,353 | 1,554.0 - 1,516.0 530,204 | 1,508.0 - 1,463.0 369,278 | 2,166.0 - 2,144.0 191,890 | 2,212,849 AF |
| MP, or Active Conservation Storage, AF | 1,455.6 - 1,428.0 193,183 | 1,729.25 - 1,697.0 89,639 | 1,892.45-1,860.0 71,926 | 1,516.0 - 1,435.0 242,528 | 1,463.0 - 1,430.0 49,474 | 2,144.0 - 2,107.8 143,878 | 790,628 AF |
| Inactive Storage, AF | 1,428.0 - 1,407.8 25,989 | 1,697.0 - 1,693.0 3,546 | 1,860.0 - 1,855.5 2,975 | | | 2,107.8 - 2,090.0 24,172 | 56,682 AF |
| Dead Storage, AF | 1,407.8 - 1,395.0 248 | 1,693.0 - 1,680.0 4,969 | 1,855.5 - 1,849.0 1,256 | | | 2,090.0 - 2,078.0 4,402 | 10,875 AF |
| Gross Storage, AF | 1,488.3 - 1,395.0 942,408 | 1,757.3 - 1,680.0 313,290 | 1,923.7 - 1,849.0 259,510 | 1,554.0 - 1,435.0 772,732 | 1,508.0 - 1,430.0 418,752 | 2,166.0 - 2,078.0 364,342 | 3,071,034 AF |
| Design Sediment Reserve Storage | 23,750 AF for 50 years | 14,950 AF for 100 years | 18,600 AF for 100 years | 40,000 AF for 100 years | 51,500 AF for 50 years | 26,000 AF for 100 years | |
| Measured Sediment Inflow | 22,597 AF (1968 to 2001) | 1,278 AF (1955 to 1996) | 1,267 AF (1956 to 1996) | 15,066 AF (1964 to 1995) | 28,704 AF (1948 to 1993) | 13,044 AF (1950 to 2000) | |
| **OUTLET WORKS** | | | | | | | (7) In addition to the gated conduit, Kanopolis has an uncontrolled port opening 3.5’x13.75’ in the 10’ pier separating the two service gate openings. Crest elevation of the port is 1,463 ft msl. The max discharges given for the outlet is the combined total of the port and gates. (8) River outlet crest elev is 2,090 ft msl. Crest elev of sluices under spillway is 2,134.82 ft msl. River outlet capacity at MP is 804 cfs, at top of flood pool is 909 cfs. Cedar Bluff also has an irrig canal outlet on Y junction from river outlet, 5.5’ pipe to control house, canal flow controlled by 4’x5’ gate (not used since 1978, irrigation district disbanded in 1994). Also a hatchery supply line from 18” valve on canal outlet, capacity 10 cfs. Lake storage owned by KS, for benefit of recreation and F&W. All releases coordinated with Kansas KDWP. (9) 2,000 AF annual storage supply contract for Russell. |
| Location | Left Abutment | Center of Dam | Right Abutment | Right Abutment | Right Abutment | Left Abutment | |
| River Outlet Type | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit | Gated Conduit (7) | Gated Conduit to River | |
| Number and Size of Conduit | 1 - 12.5’ | 7’ Cond to 60” pipe (5) | 4.5’ Conduit to 48” pipe | 1 - 12’ | 1 - 14’ | 1 - 5.5’ | |
| Length of Conduit, feet | 575 | (5) | 538 | 1,097 | 2,443 | 863.5 | |
| Entrance Crest Elevation | 1,407.8 ft msl | 1,693 ft msl | 1,855.5 ft msl | 1,450.0 ft msl | 1,415.0 ft msl | 2,090.0 ft msl | |
| Gated Sluice, Number and Size | None | See note below | None | None | None | 8 - 5’x5’, gated (8) | |
| Discharge Cap, Top of Flood Control Pool | 5,200 cfs | 220 cfs (5) | 480 cfs | 6,500 cfs | 6,400 cfs (7) | 3,520 cfs (outlet, sluices) (8) | |
| Disch Cap, Top of MP (Conservation) Pool | 4,000 cfs | 220 cfs (5) | 385 cfs | 5,300 cfs | 4,500 cfs (7) | 7,949 cfs (outlet, sluices) (8) | |
| Service Gates, Number, Size, Type | 2 - 6.5’x8’ Slide Gates | 1 - 4’x5’ to stilling well (5) | 1 - 3.5’x3.5’ Slide Gate | 2 - 6’x12’ Service Gates | 2 - 6’x12’ | 1 - 4’x5’ | |
| Emergency Gates, Number and Size | 1 - 9’x12’ Slide Gates | 1 - 4’x5’ (5) | 1 - 3.5’x3.5’ Slide Gate | 2 - 6’x12’ Slide Gates | 1 - 6’x12’ | 1 - 4’x5’ | |
| Low Flow Gates, Number and Size | None | None | None | 2 - 2’x2’ Slide Gates | None | None | |
| Provision for Irrigation | None | 2 - 5.5’x8’ openings (5) | None | None | None | 1 - 4’x5’ (8) | |
| Provision for Power | None | None | None | None | Provision for future steel | None | |
| Provision for Municipal Supply | Supplied thru river releases. | None | None | None | penstock in outlet tunnel for | See (9), supplied by release | |
| | City of Beloit has contracted for up to 2,000 AF of annual storage releases. Mitchell County Rural Water District No. 2 has contracted for up to 1,009 AF of annual storage releases. | Note: 15 - 5’ x 5’ gated sluices located in concrete ogee section below spillway crest. Crest elevation at sluice entrance = 1,720.0. Discharge capacity at top of conserv pool = 4,800 cfs, top, flood pool = 15,350 cfs. | Note: When reservoir elevation is below 1,860, the outlet gate openings must be reduced to prevent air entrainment in conduit. | Note: Low flow gates are mounted in the service gates Low flow gates are used for river releases up to 200 cfs. | power. In 2002, 12,500 AF of MP storage reallocated to water supply, contracted to State of Kansas. State sub-leased portion of space to Post Rock Irrigation District which already has a pump outlet near intake tower. | to river, pump to Big Ck. Note: Spillway also has a gated orifice section at center with 1 - 14.5’ x 9.58’ radial gate, crest elev 2,144. Spillway cap includes ogee and orifice. Sluices located in ogee section below crest. | |

**Abbreviations**
ac = acres
AF = acre-feet
ft = feet
msl = elevation above mean sea level
cfs = cubic feet per second
MP = multipurpose pool elevation

**SUMMARY OF ENGINEERING DATA**
**SMOKY HILL RIVER BASIN PROJECTS**

U.S. Army Corps of Engineers
Kansas City District
December 2002

Plate 2E

**APPENDIX A**
**CORPS OF ENGINEERS PROJECTS**

BLUE SPRINGS LAKE

CLINTON LAKE

HARLAN COUNTY LAKE

HARRY S. TRUMAN RESERVOIR

HILLSDALE LAKE

KANOPOLIS LAKE

LONG BRANCH LAKE

LONGVIEW LAKE

MELVERN LAKE

MILFORD LAKE

PERRY LAKE

POMME DE TERRE LAKE

POMONA LAKE

RATHBUN LAKE

SMITHVILLE LAKE

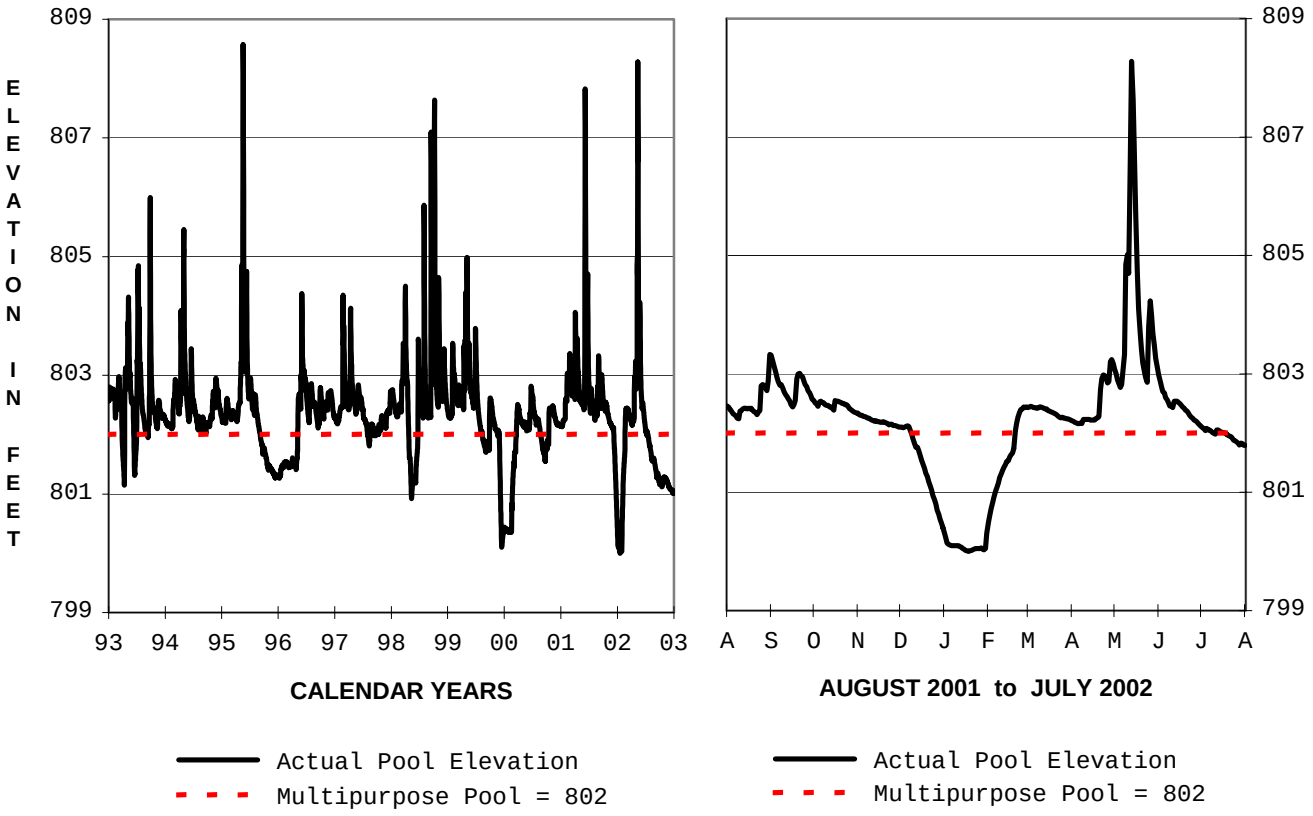
STOCKTON LAKE

TUTTLE CREEK LAKE

WILSON LAKE

# BLUE SPRINGS LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

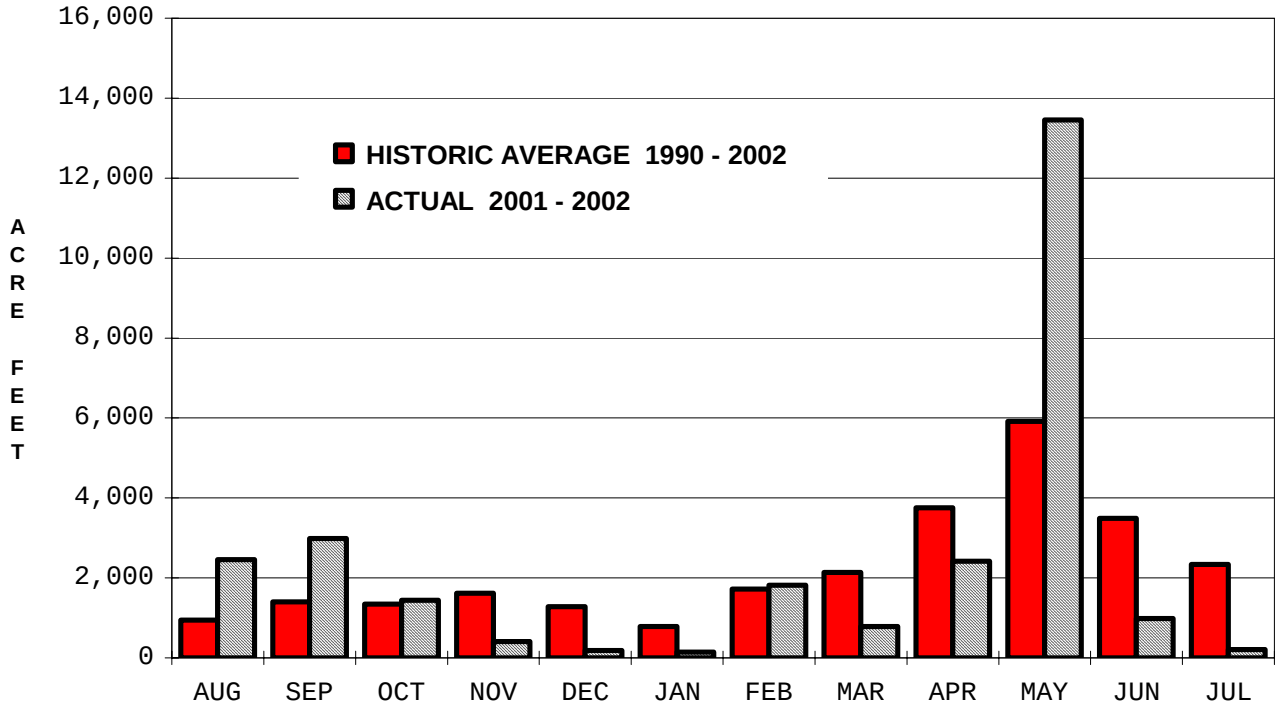



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **802.46<br>1 Aug 01** | **801.80<br>31 Jul 02** | **808.31<br>12-13 May 02** | **800.00<br>17-18 Jan 02** | **816.37<br>16-17 May 90** | **800.00<br>17-18 Jan 02** |

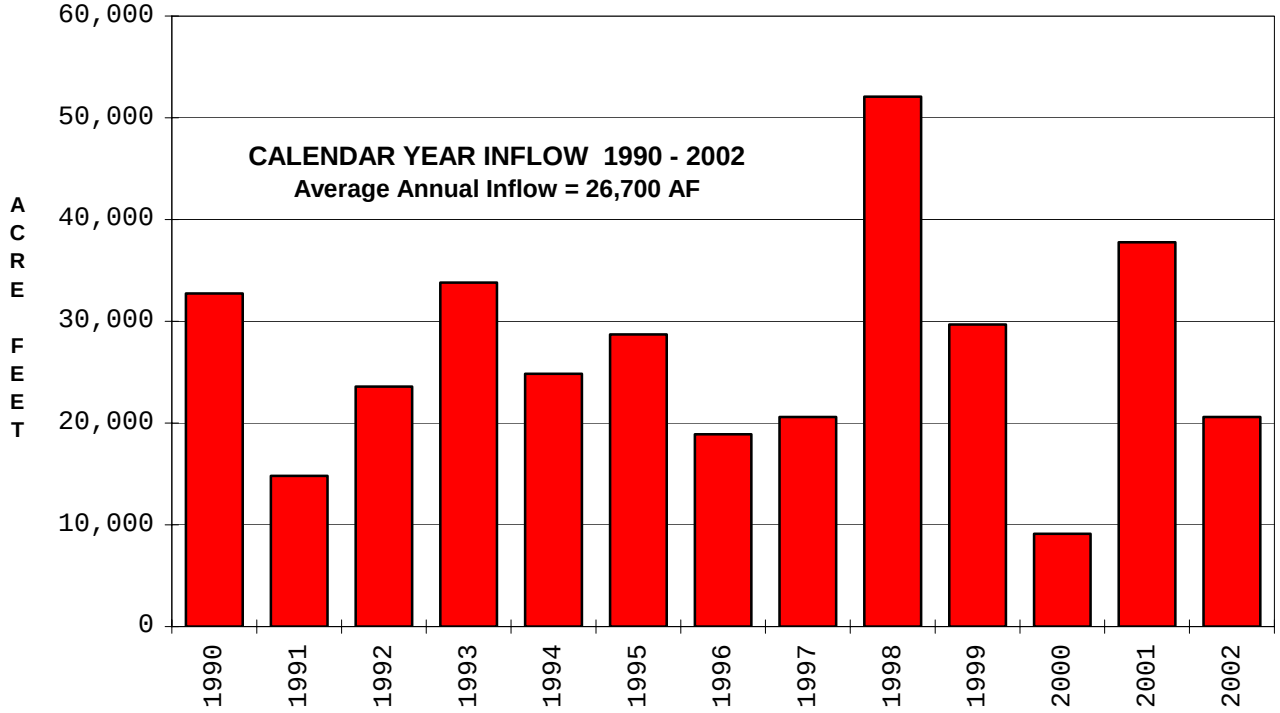
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **1,250<br>13 May 02** | **27,297 ( 102%)<br>33,630 AF previous period** | **513<br>14 May 02** | **0, Several days when pool was below 802.00** |

All releases are to the river. No minimum release requirement.

## BLUE SPRINGS LAKE MONTHLY INFLOW

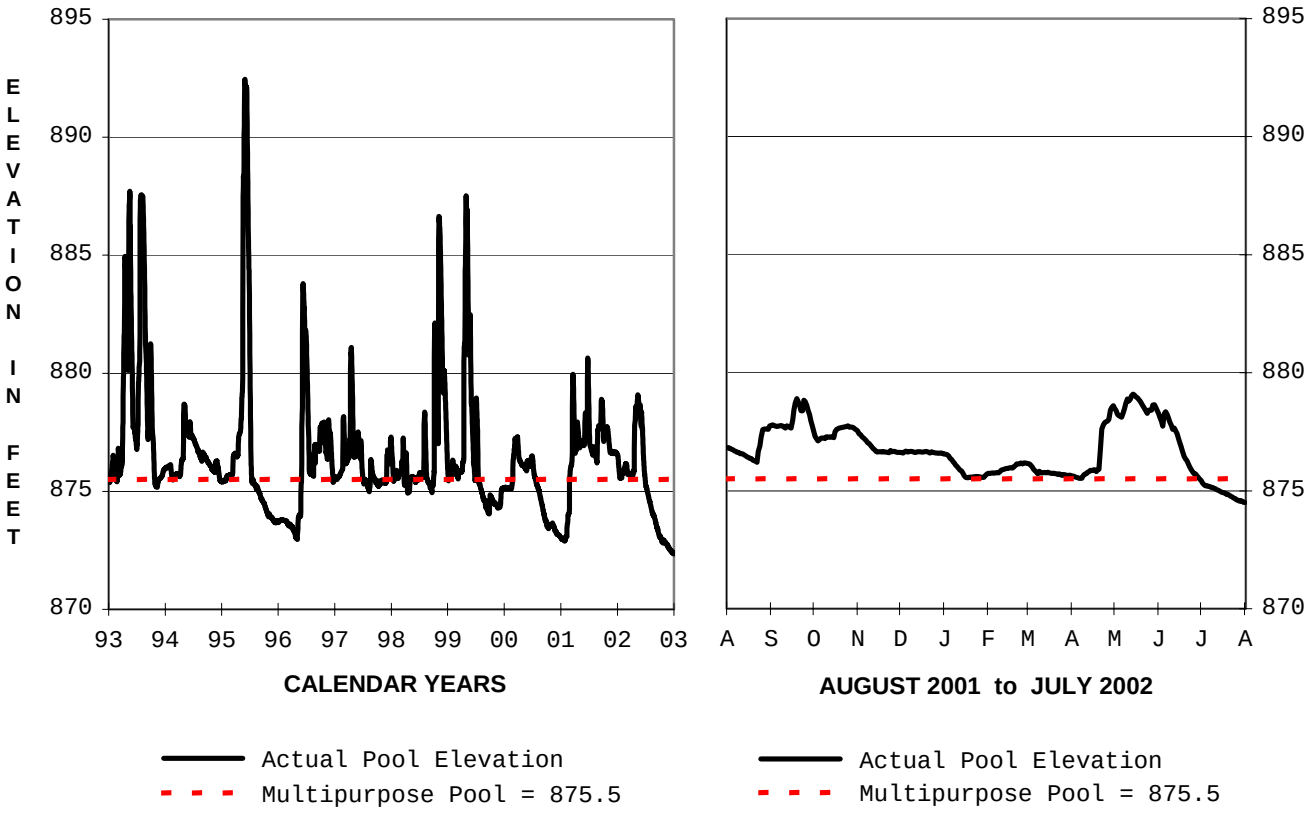



## BLUE SPRINGS LAKE ANNUAL INFLOW



# CLINTON LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

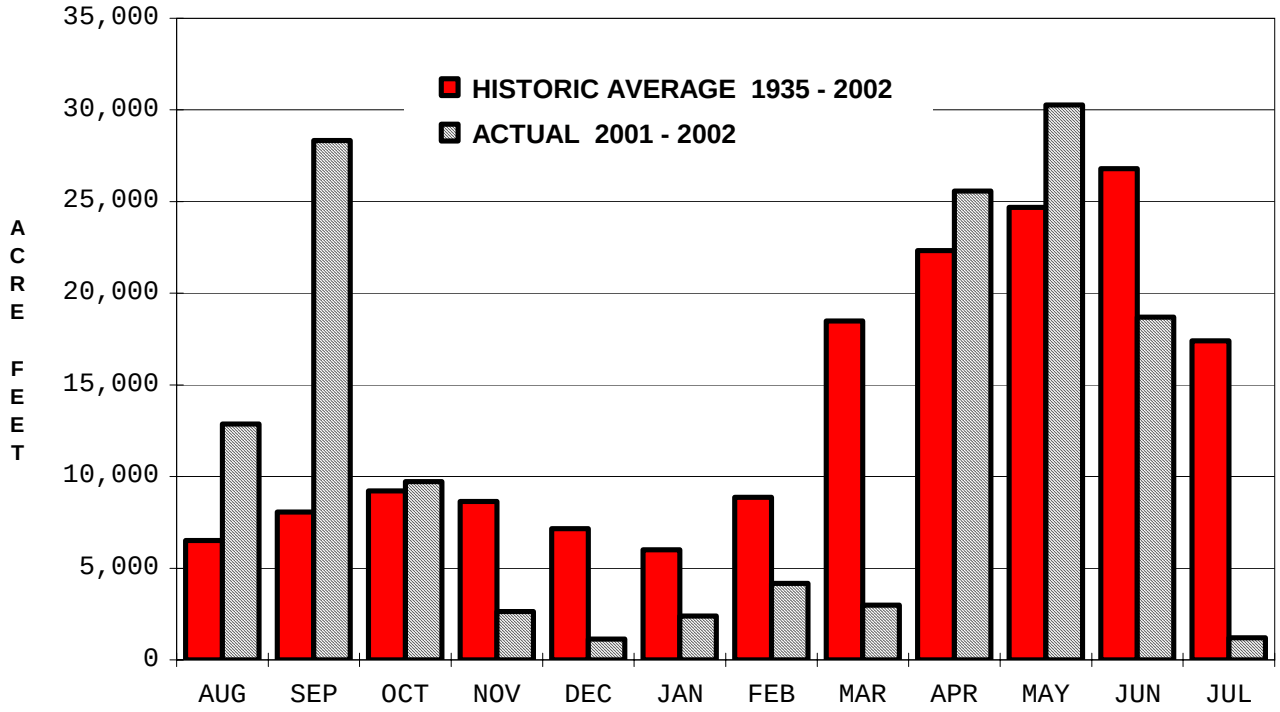



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **876.83<br>1 Aug 01** | **874.52<br>31 Jul 02** | **879.10<br>14 May 02** | **874.51<br>30-31 Jul 02** | **892.48<br>29 May 95** | **871.60<br>18-19 Aug 89** |

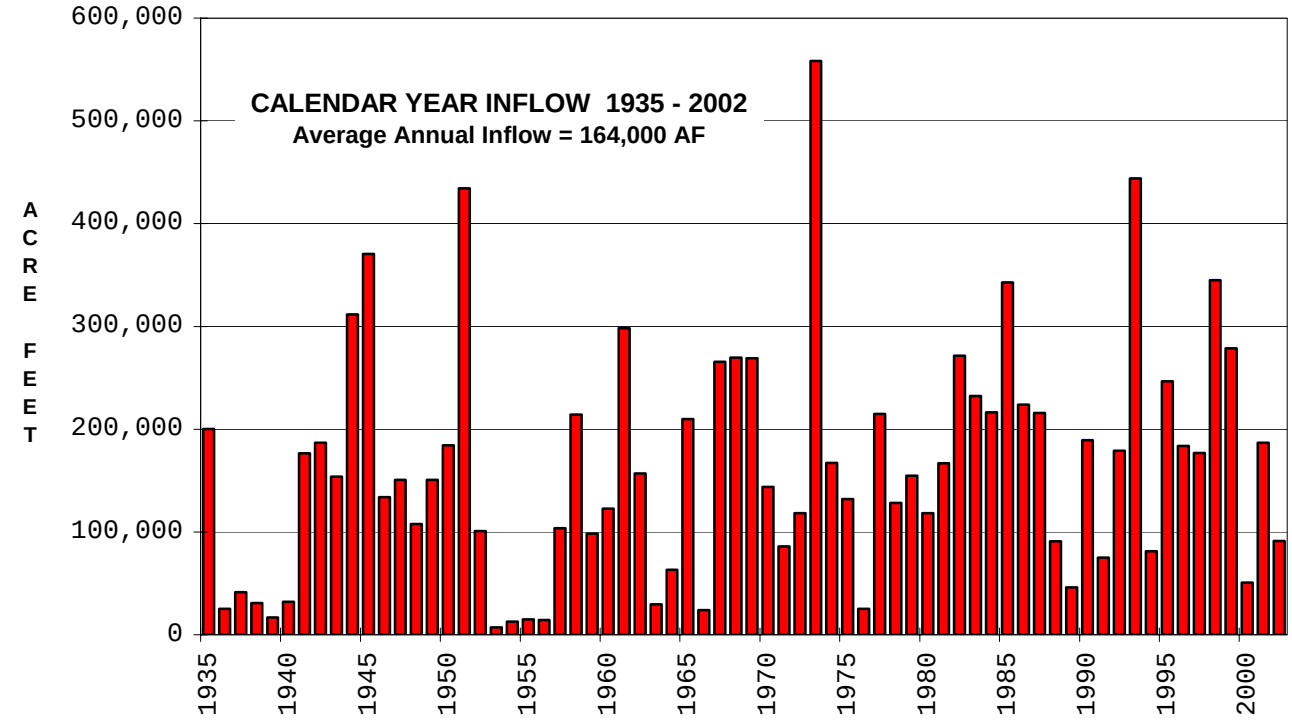
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,000<br>21-22 Apr 02** | **139,973 ( 85%)<br>136,443 AF previous period** | **1,000<br>20 Sep to 2 Oct 01** | **7 Most days<br>16 Nov 01 to 1 Mar 02** |

Outflows are those to river only. Minimum release is 7 to 21 cfs. Releases cut to 0 for short maintenance periods.

## CLINTON LAKE MONTHLY INFLOW

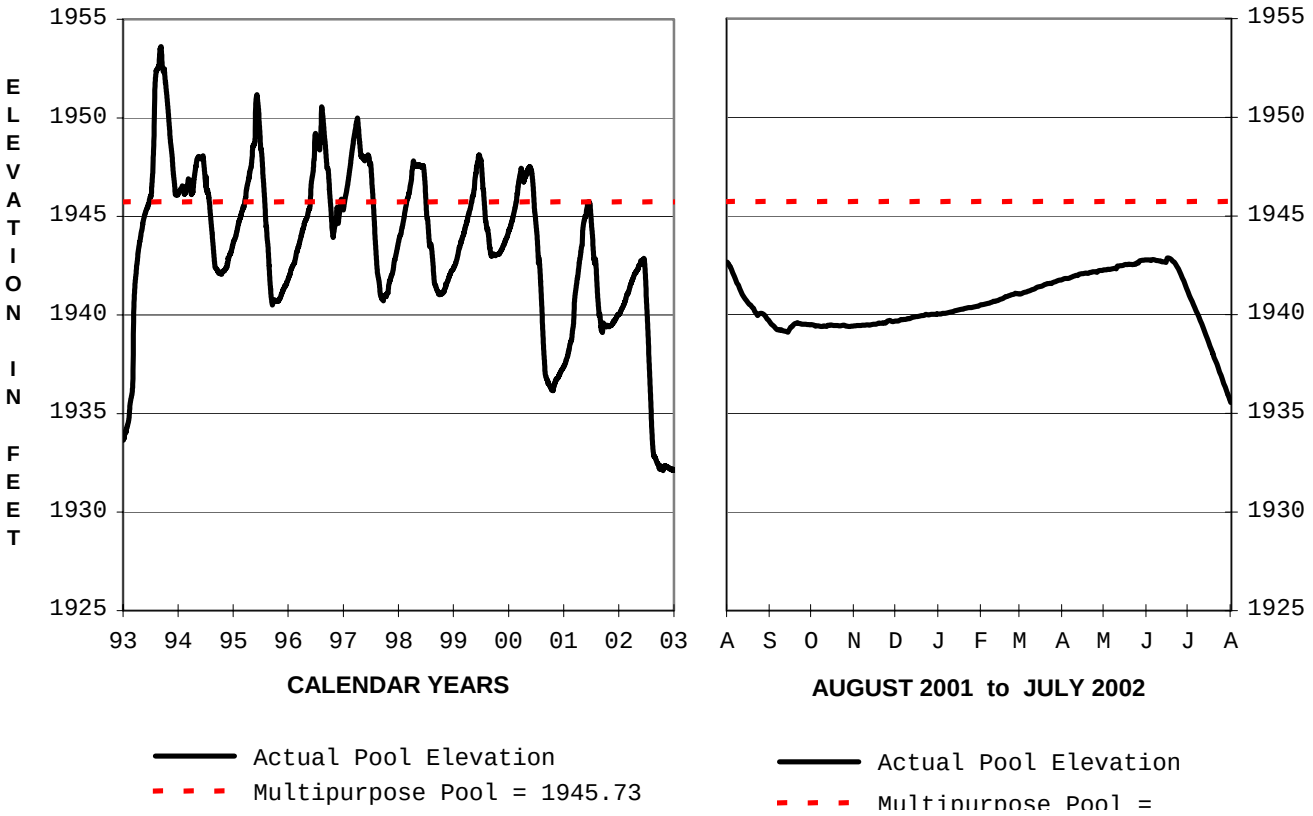



## CLINTON LAKE ANNUAL INFLOW



# HARLAN COUNTY LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

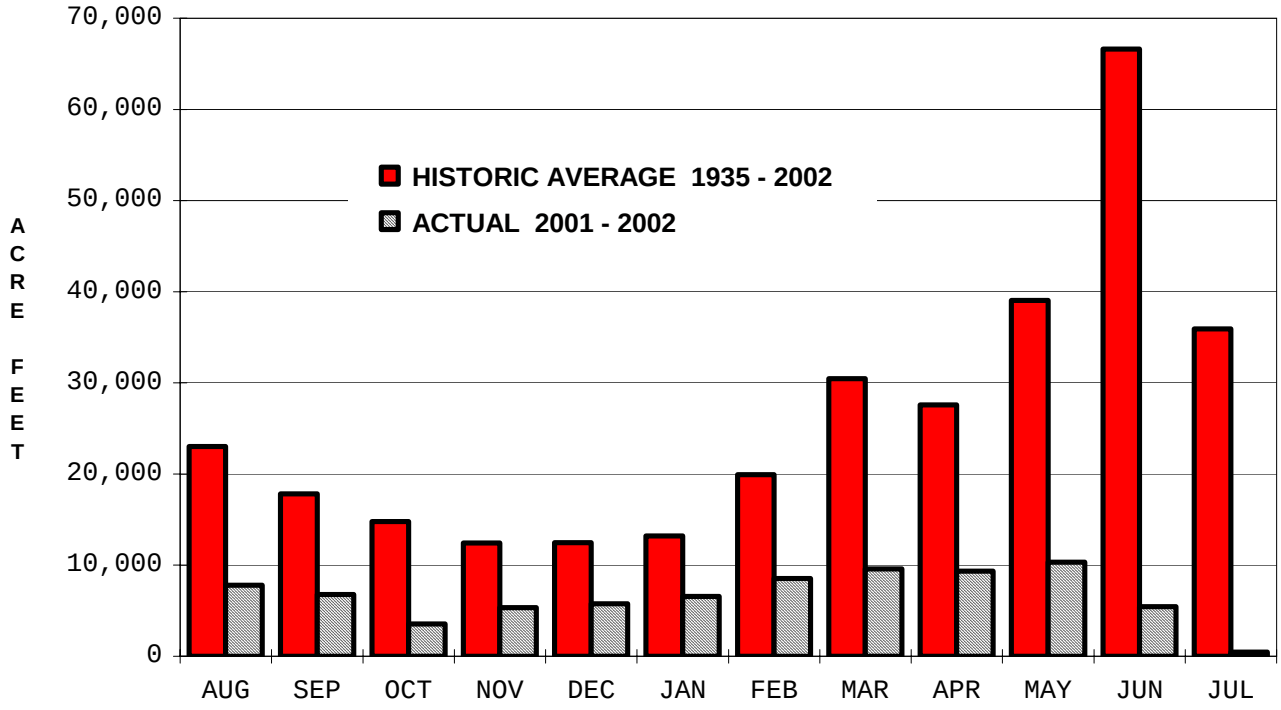



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1942.66<br>1 Aug 01** | **1935.75<br>31 Jul 02** | **1942.89<br>16-17 Jun 02** | **1935.61<br>31 Jul 02** | **1955.66<br>5 Apr 60** | **1928.21<br>27-28 Oct 91** |

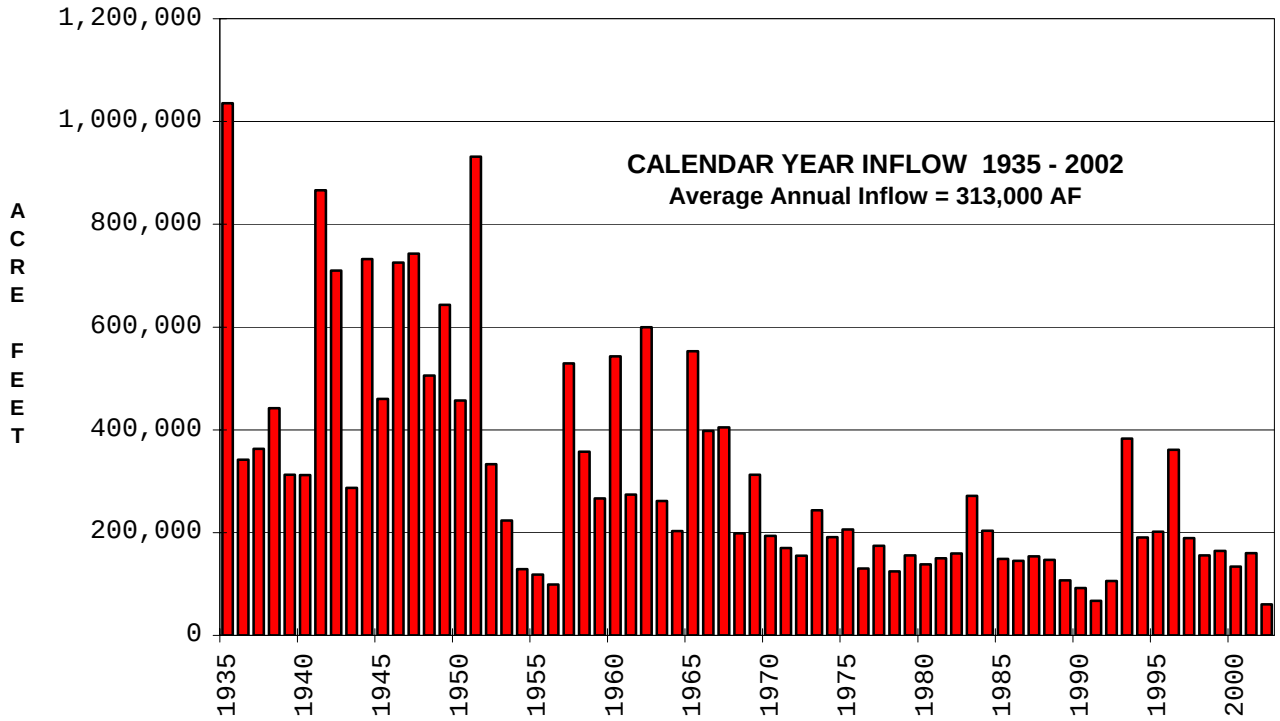
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **800<br>15 Sep 01** | **79,498 ( 25%)<br>155,506 AF previous period** | **700<br>7 Aug 01** | **0, Minimum release varies from 0 to 10 cfs** |

Max daily outflow to river occurred as part of normal releases for irrigation. Max release w/2 canals was 979 cfs.

## HARLAN COUNTY LAKE MONTHLY INFLOW

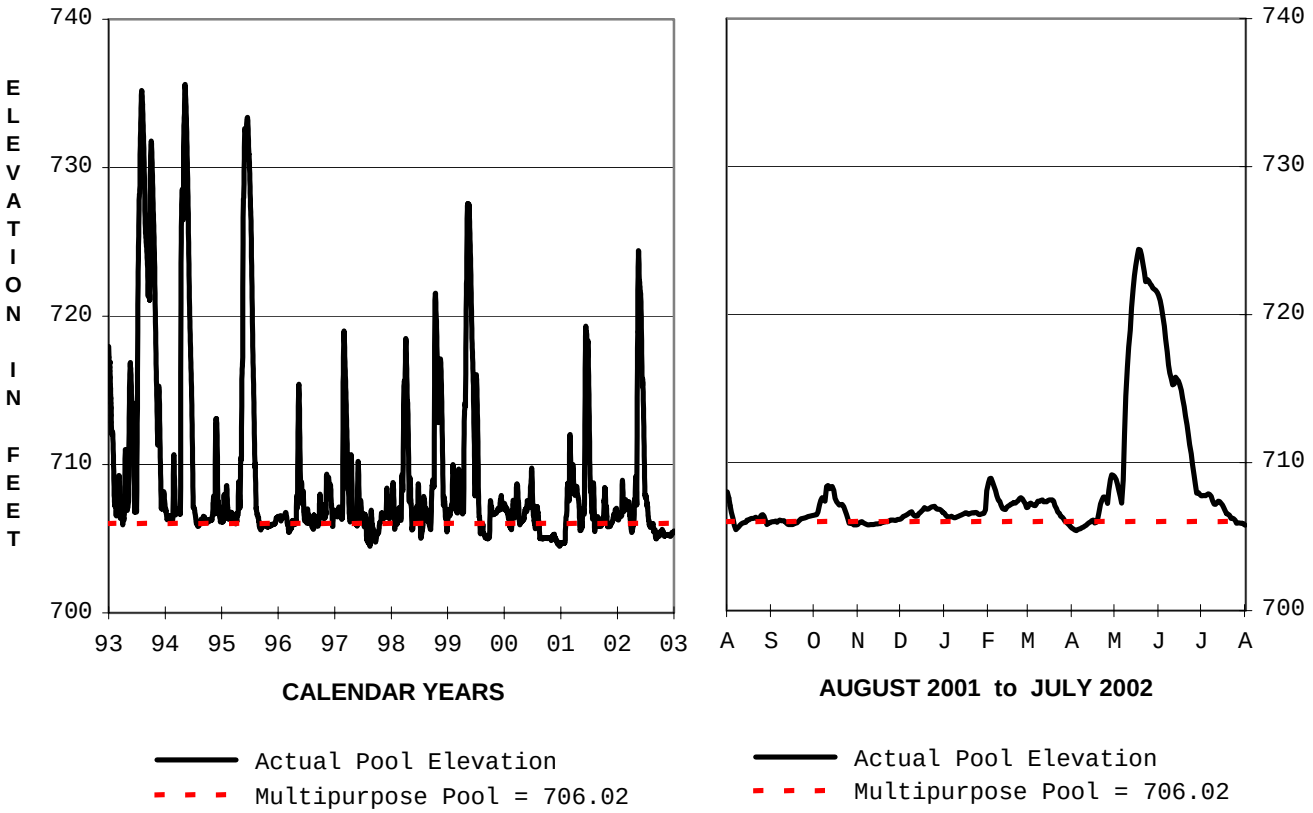



## HARLAN COUNTY LAKE ANNUAL INFLOW



# HARRY S. TRUMAN RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

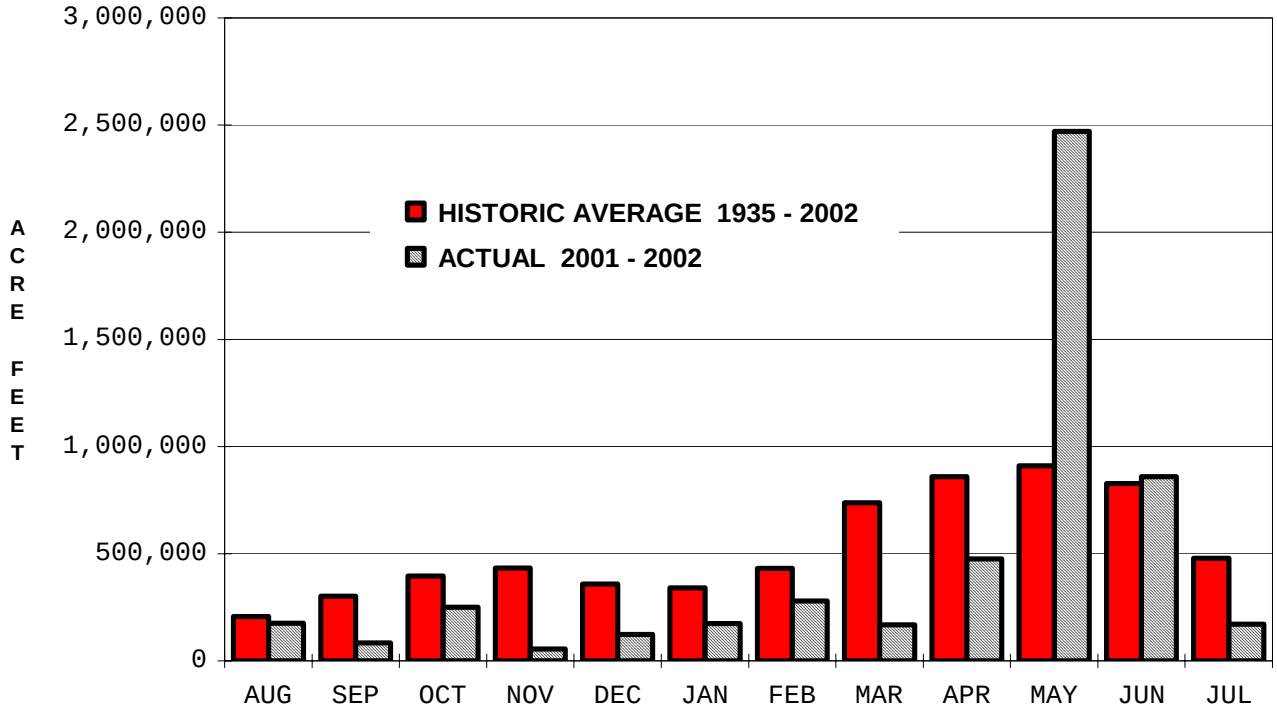



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **708.02<br>1 Aug 01** | **705.86<br>31 Jul 02** | **724.53<br>19 May 02** | **705.41<br>4-5 Apr 02** | **738.72<br>12 Oct 86** | **703.42<br>10 Apr 81** |

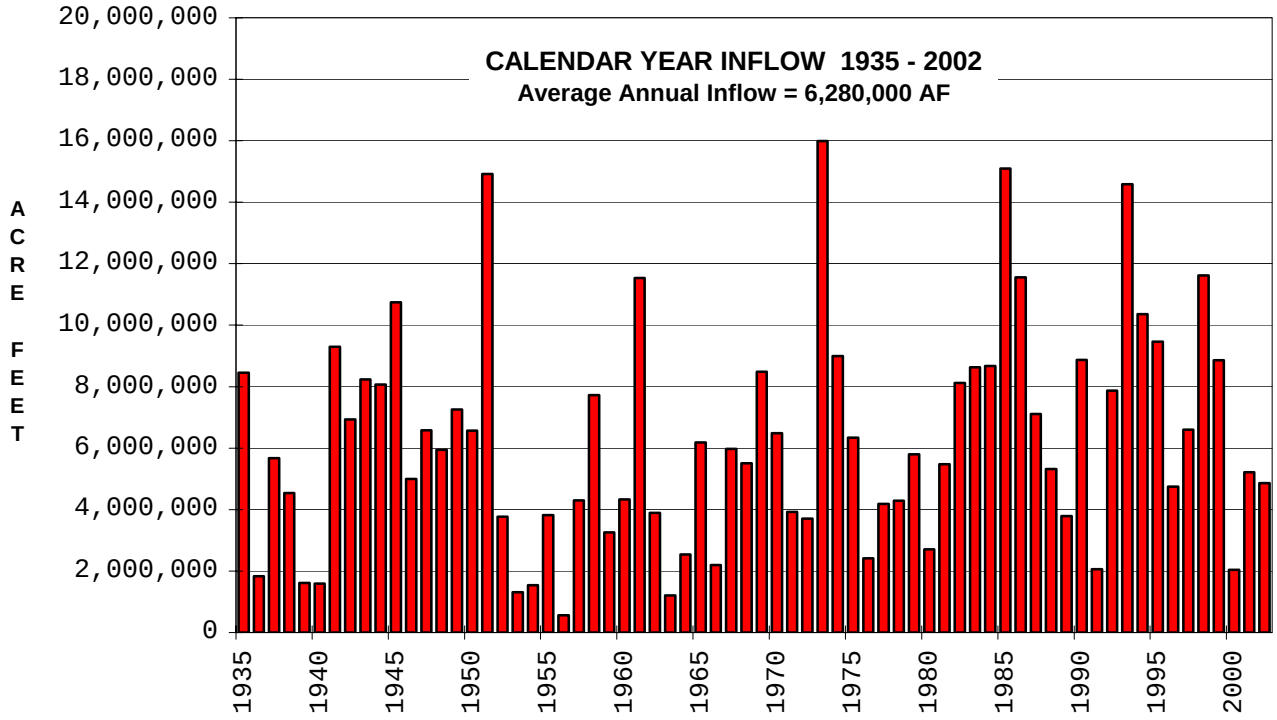
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Max Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **107,100<br>8 May 02** | **5,285,163 ( 84%)<br>4,789,548 AF previous period** | **52,529<br>6 Jun 02** | **0<br>Several periods** |

Listed outflows include turbine releases and spill to the river. Minimum release varies during the year 0 to 3,500 cfs.

## HARRY S. TRUMAN RESERVOIR MONTHLY INFLOW

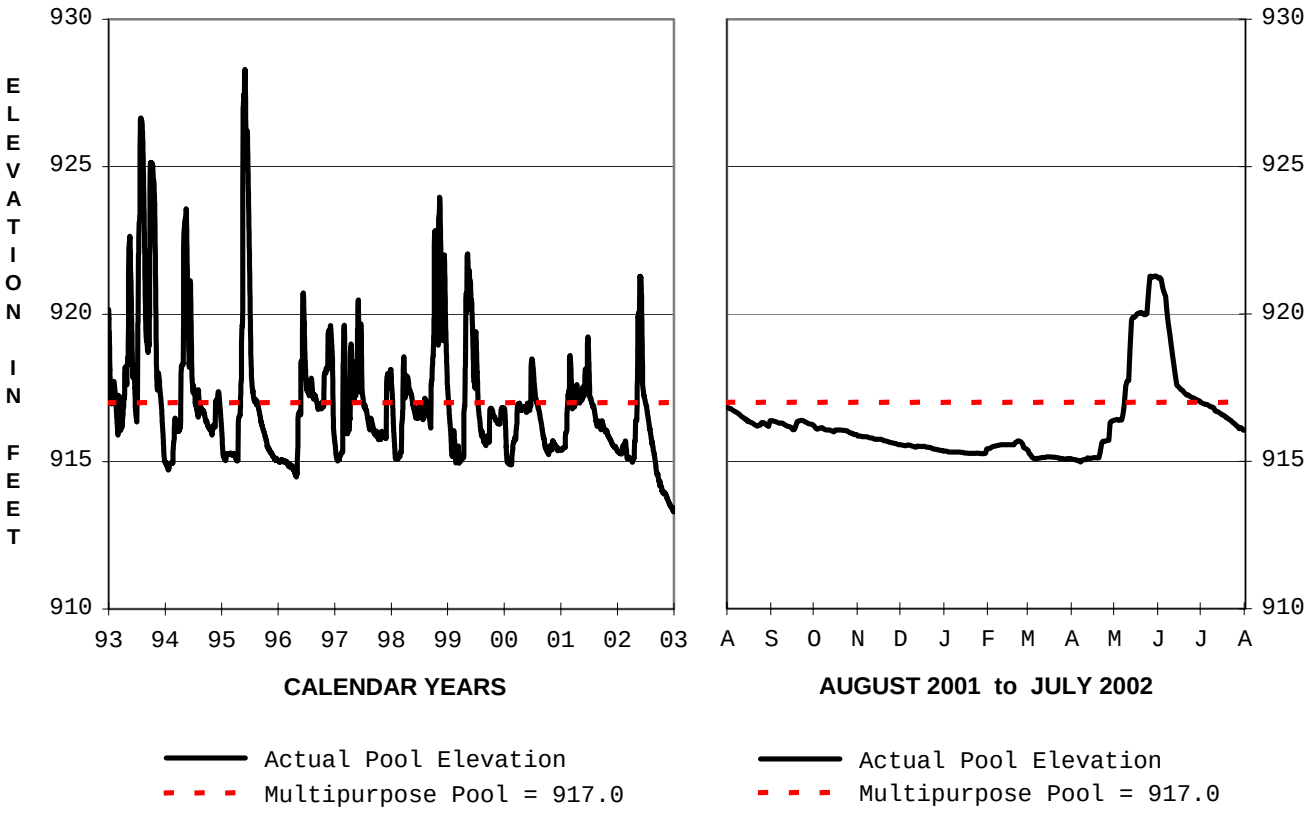



## HARRY S. TRUMAN RESERVOIR ANNUAL INFLOW



# HILLSDALE LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

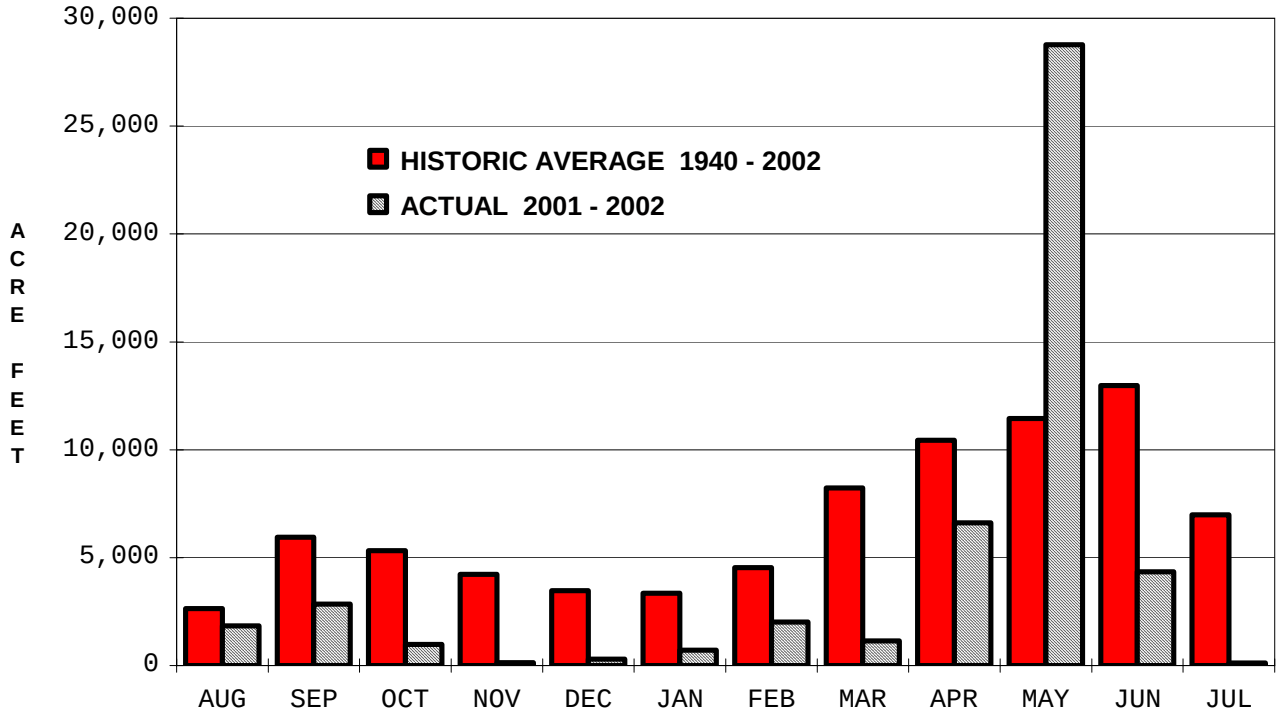



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **916.83<br>1 Aug 01** | **916.07<br>31 Jul 02** | **921.30<br>29-30 May 02** | **914.98<br>6-7 Apr 02** | **928.51<br>21 Oct 86** | **904.97<br>14-15 Nov 87** |

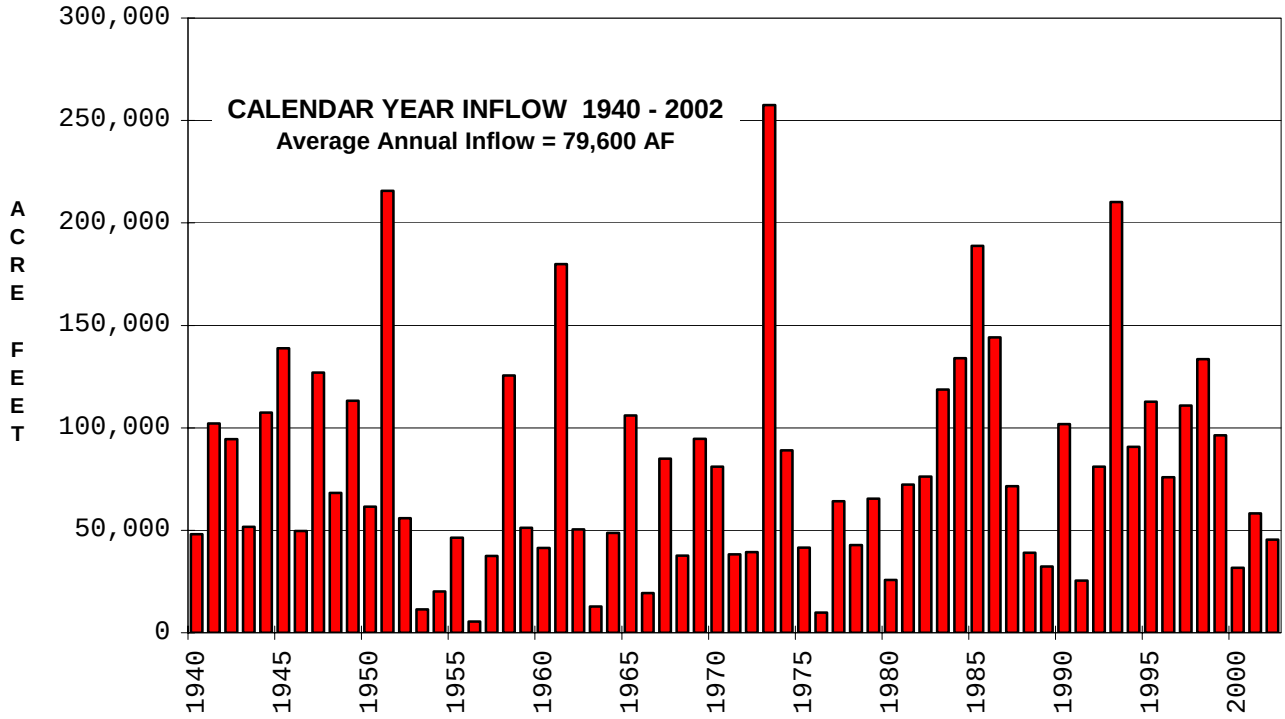
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,700<br>13 May 02** | **49,816 ( 63%)<br>59,527 AF previous period** | **1,100<br>7-13 Jun 02** | **3<br>9 Nov 01 to 22 Feb 02** |

Listed outflows are to river. Minimum required release is 3-24 cfs. Releases cut to 0 for short maintenance periods.

## HILLSDALE LAKE MONTHLY INFLOW

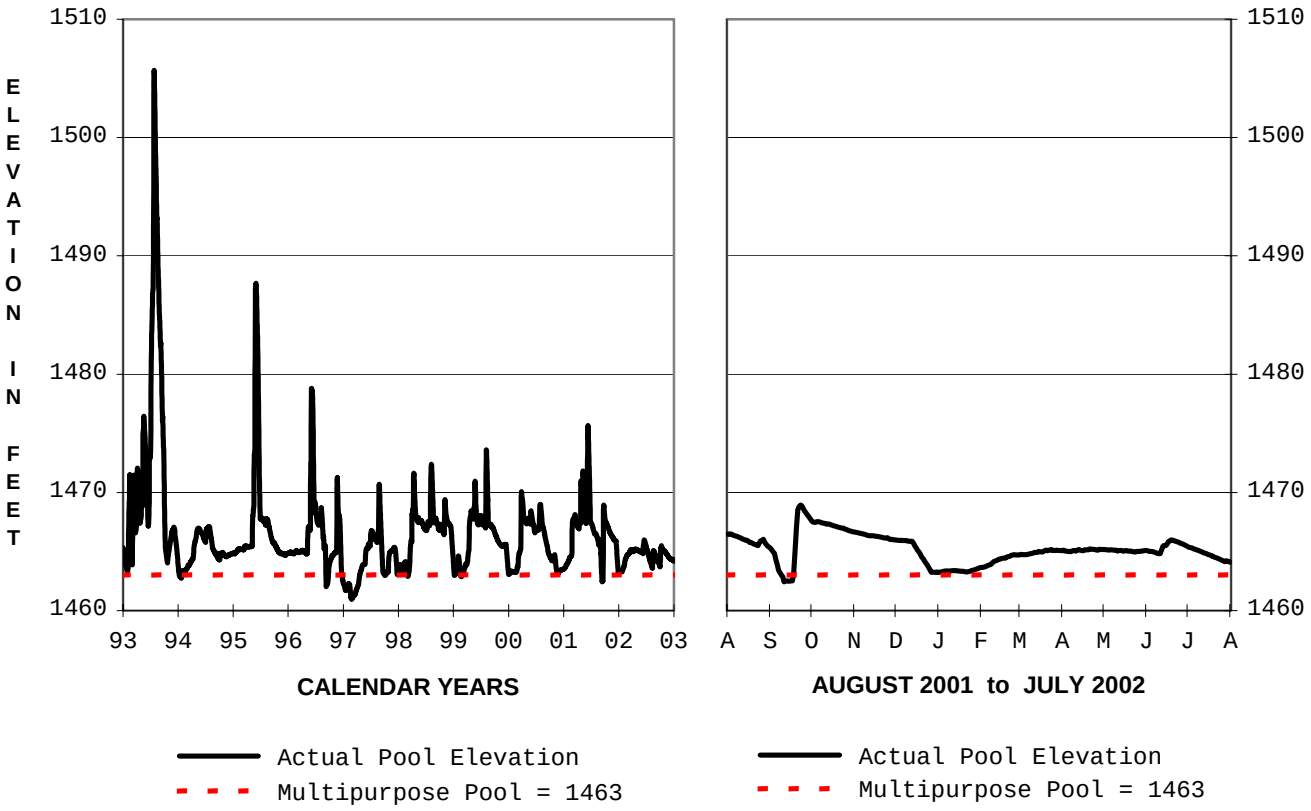



## HILLSDALE LAKE ANNUAL INFLOW



# KANOPOLIS LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

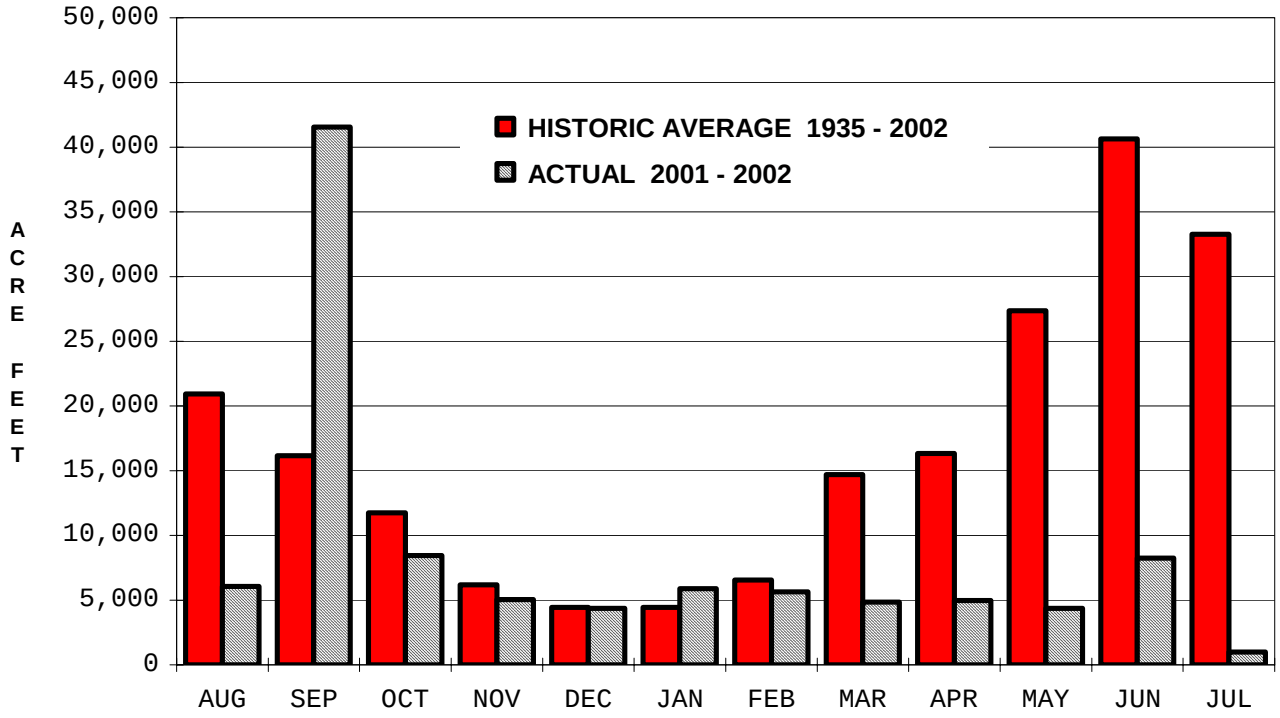



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1466.48<br>1 Aug 01** | **1464.14<br>31 Jul 02** | **1469.00<br>23 Sep 01** | **1462.44<br>11 Sep 01** | **1506.98<br>14 Jul 51** | **1452.55<br>11 Dec 88** |

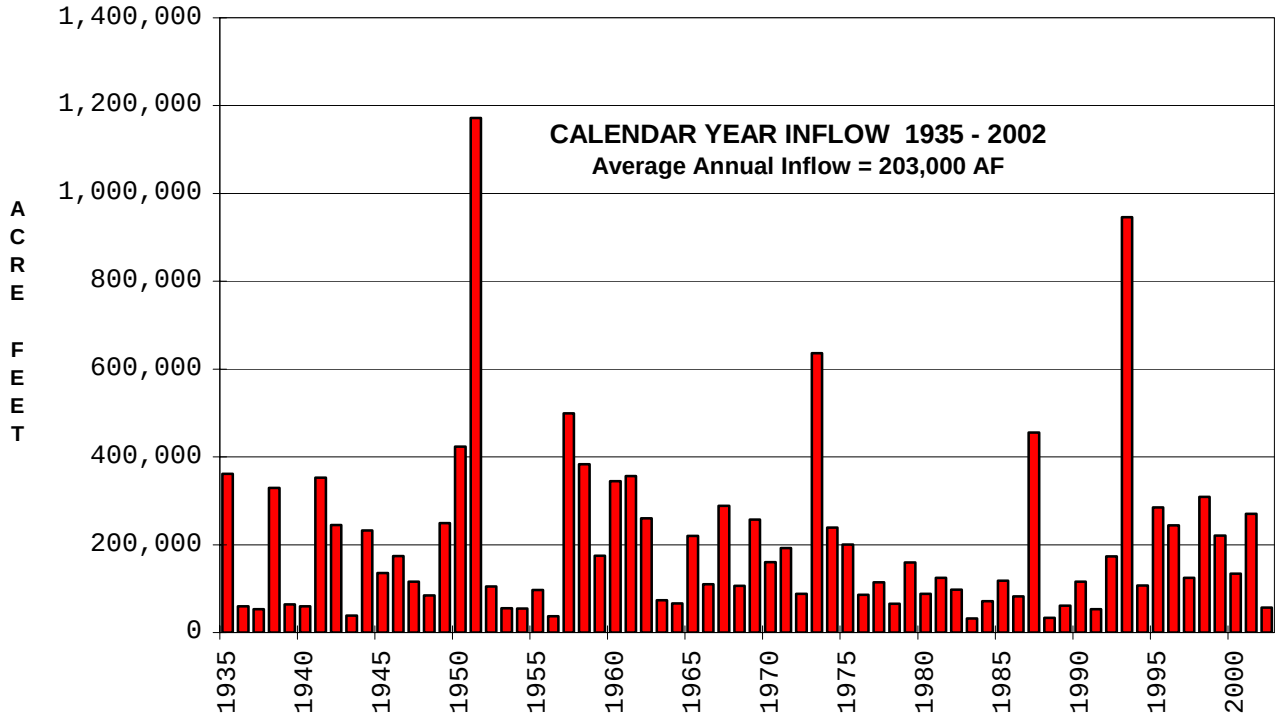
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **5,000<br>20 Sep 01** | **100,418 ( 50%)<br>225,603 AF previous period** | **1,023<br>24 Sep 01** | **10<br>31 Jan to 2 Feb 02** |

Listed outflows are total from gates and uncontrolled notch. Minimum release varies seasonally 10 to 50 cfs.

## KANOPOLIS LAKE MONTHLY INFLOW

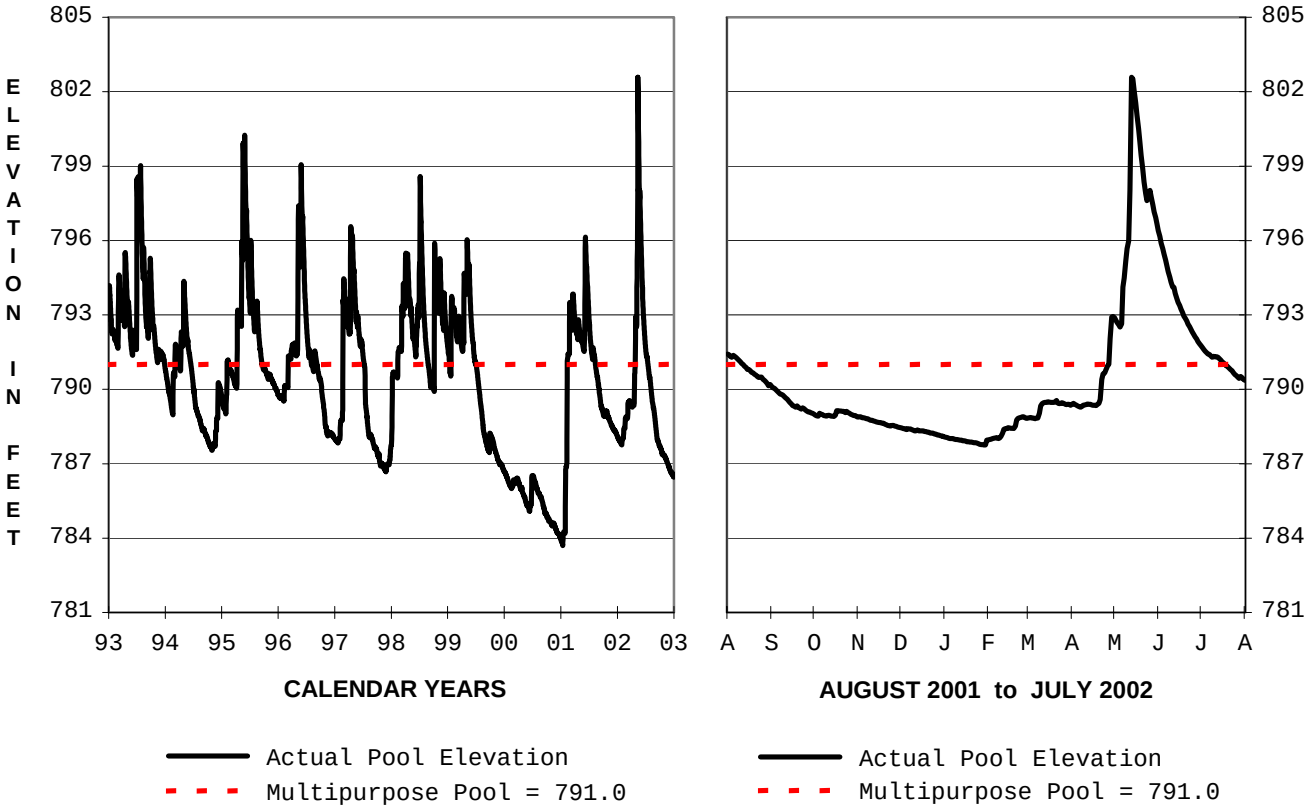



## KANOPOLIS LAKE ANNUAL INFLOW



# LONG BRANCH LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

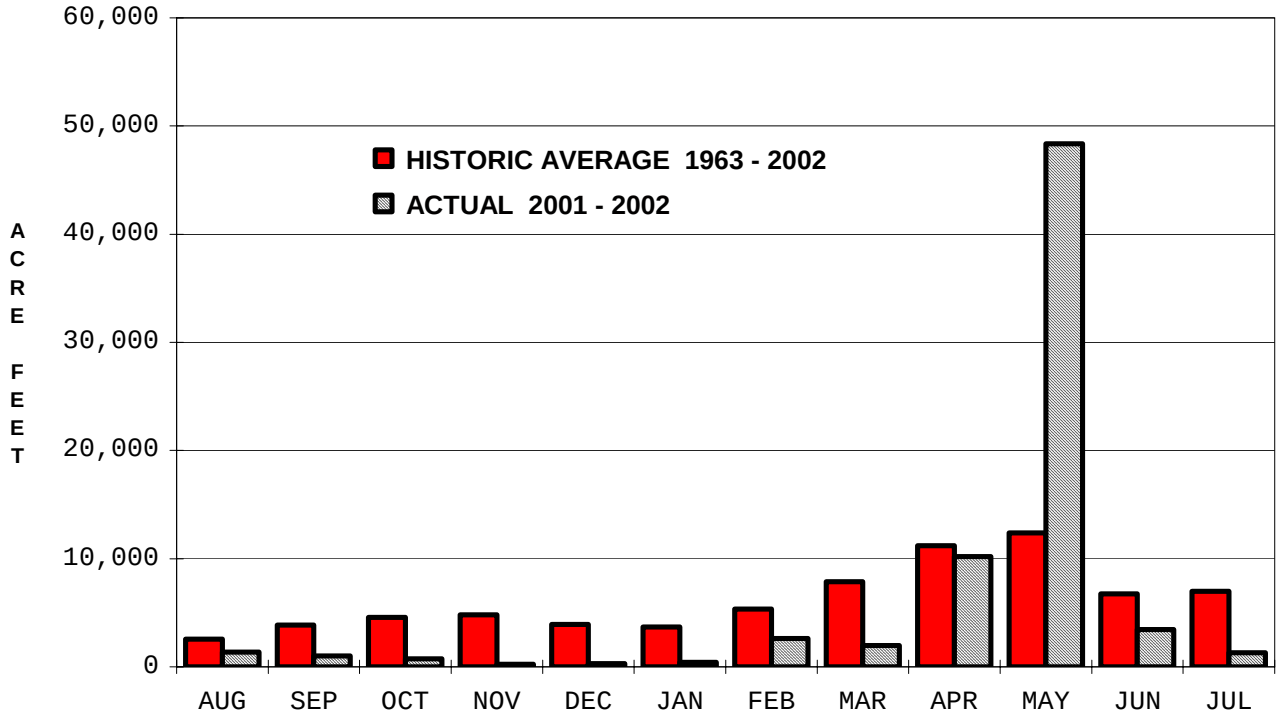



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **791.43<br>1 Aug 01** | **790.42<br>31 Jul 02** | **802.74<br>13 May 02** | **787.75<br>27 Jan 02** | **802.74<br>13 May 02** | **783.70<br>12 Jan 01** |

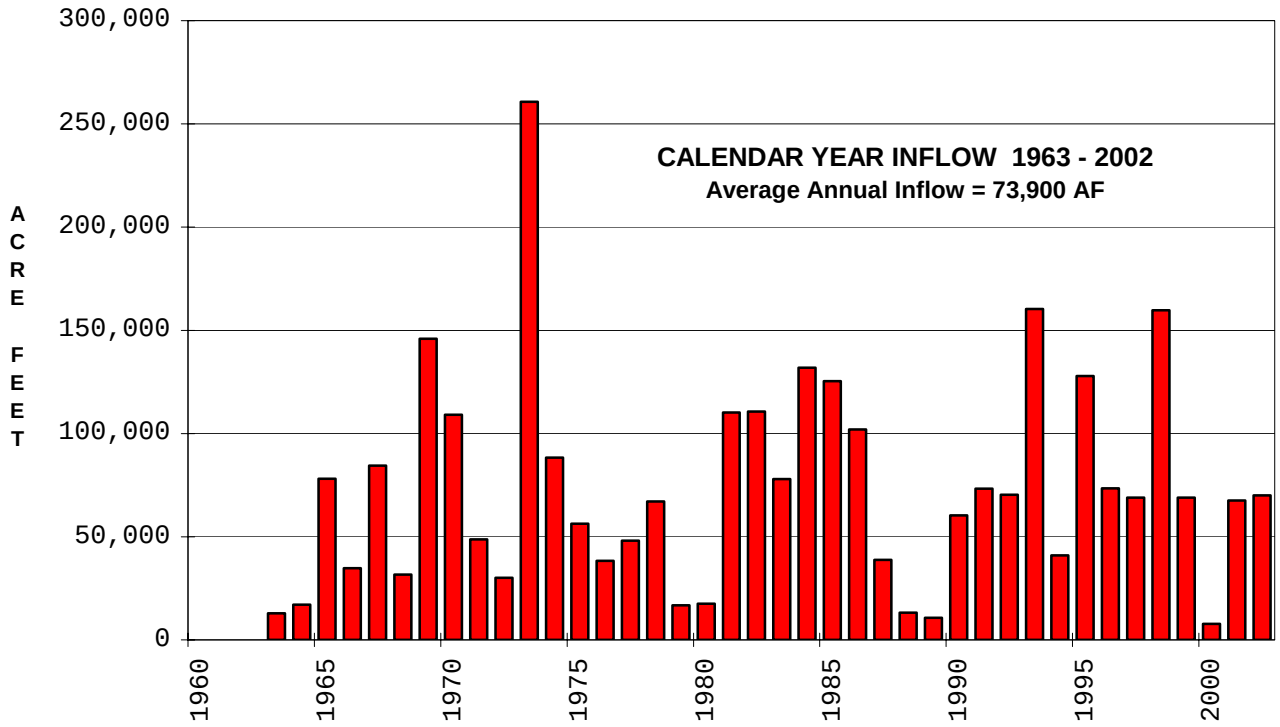
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **8,900<br>13 May 02** | **71,918 ( 97%)<br>65,967 AF previous period** | **1,109<br>14 May 02** | **7<br>27 Sep 01 to 27 Apr 02** |

Listed outflows are total to the river from the gates and the uncontrolled notch. Minimum required release is 7 cfs.

## LONG BRANCH LAKE MONTHLY INFLOW

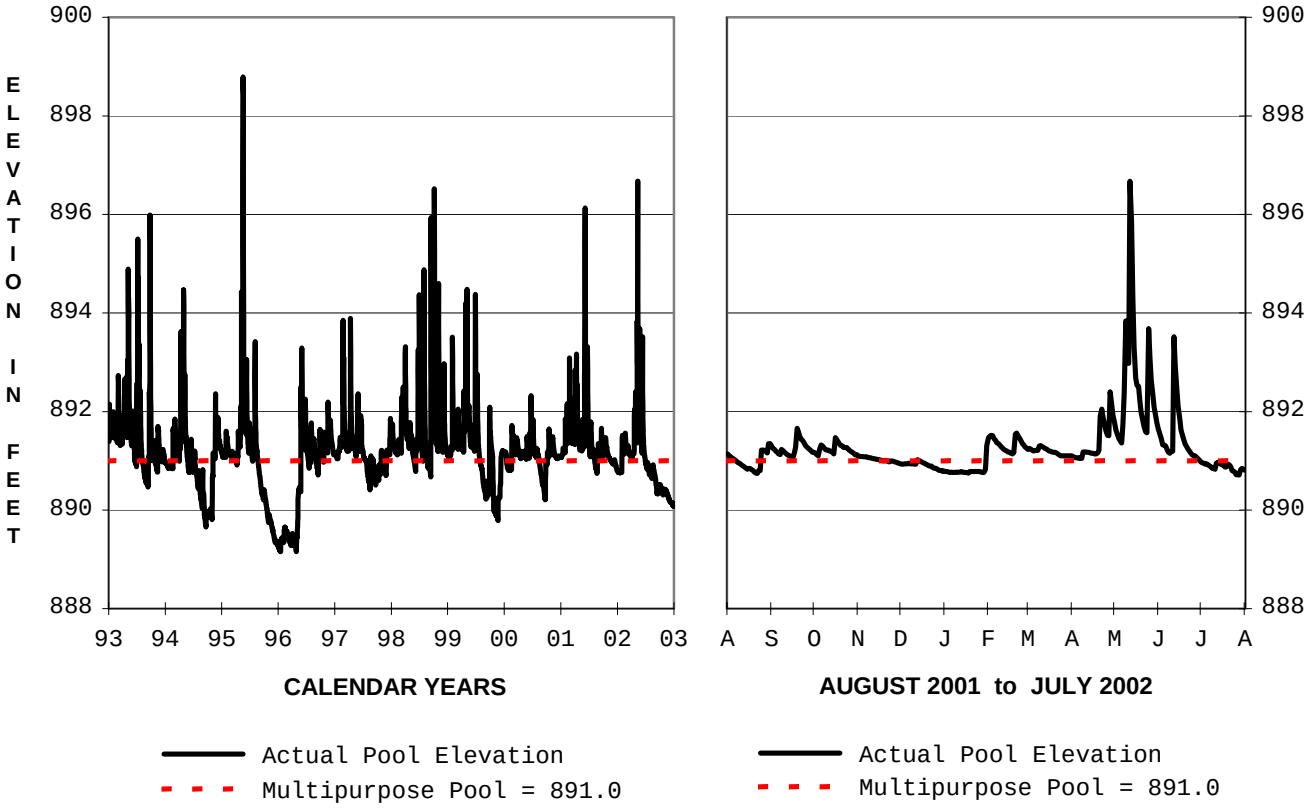



## LONG BRANCH LAKE ANNUAL INFLOW



# LONGVIEW LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

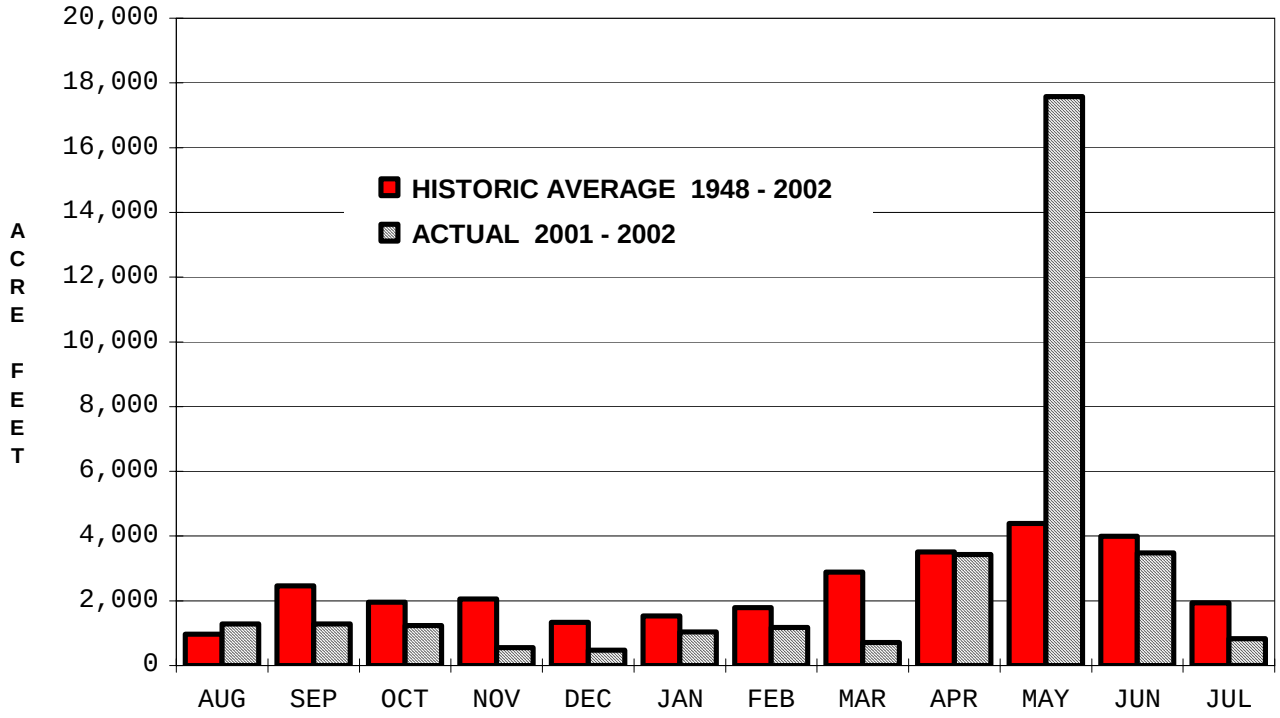



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **891.14<br>1 Aug 01** | **890.83<br>31 Jul 02** | **896.77<br>12 May 02** | **890.69<br>28 Jul 02** | **903.37<br>16 May 90** | **888.08<br>14 Sep 88** |

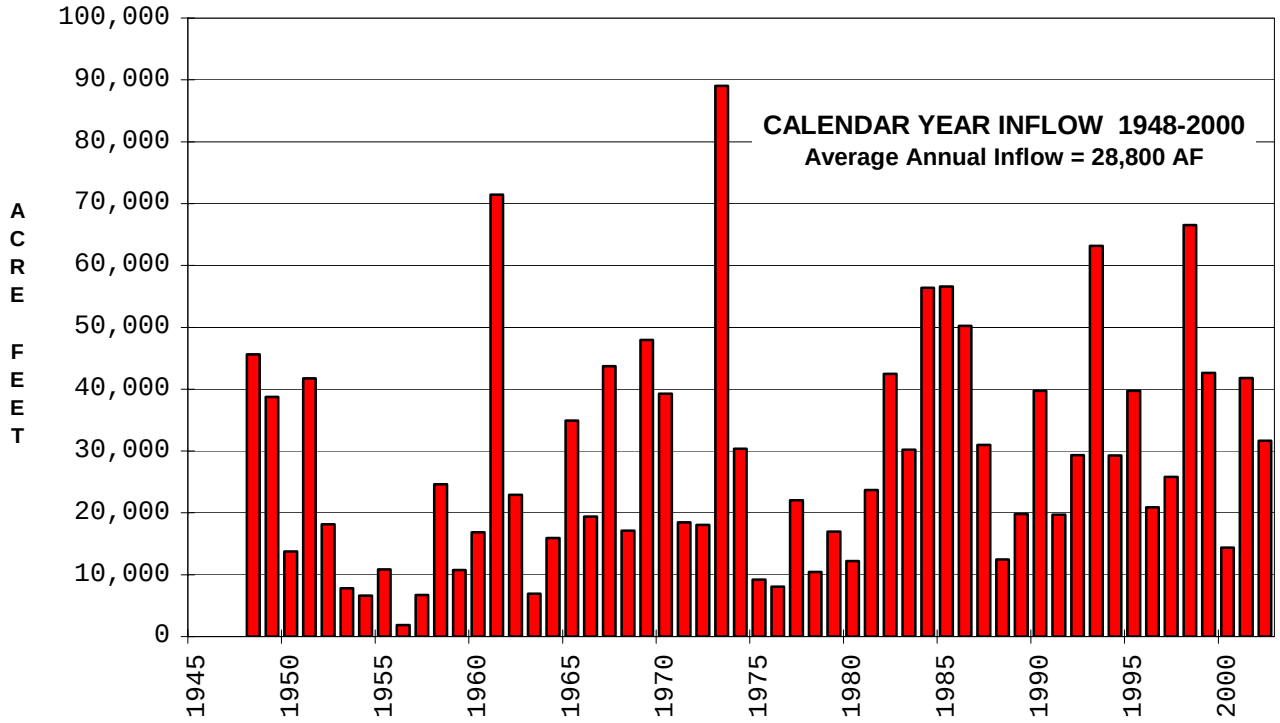
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,750<br>12 May 02** | **33,097 ( 115%)<br>42,070 AF previous period** | **1,079<br>13 May 02** | **8, Several days when pool was below 891.00** |

Listed outflows are total to the river from the gate and the uncontrolled notch. Minimum required release is 8 cfs.

## LONGVIEW LAKE MONTHLY INFLOW

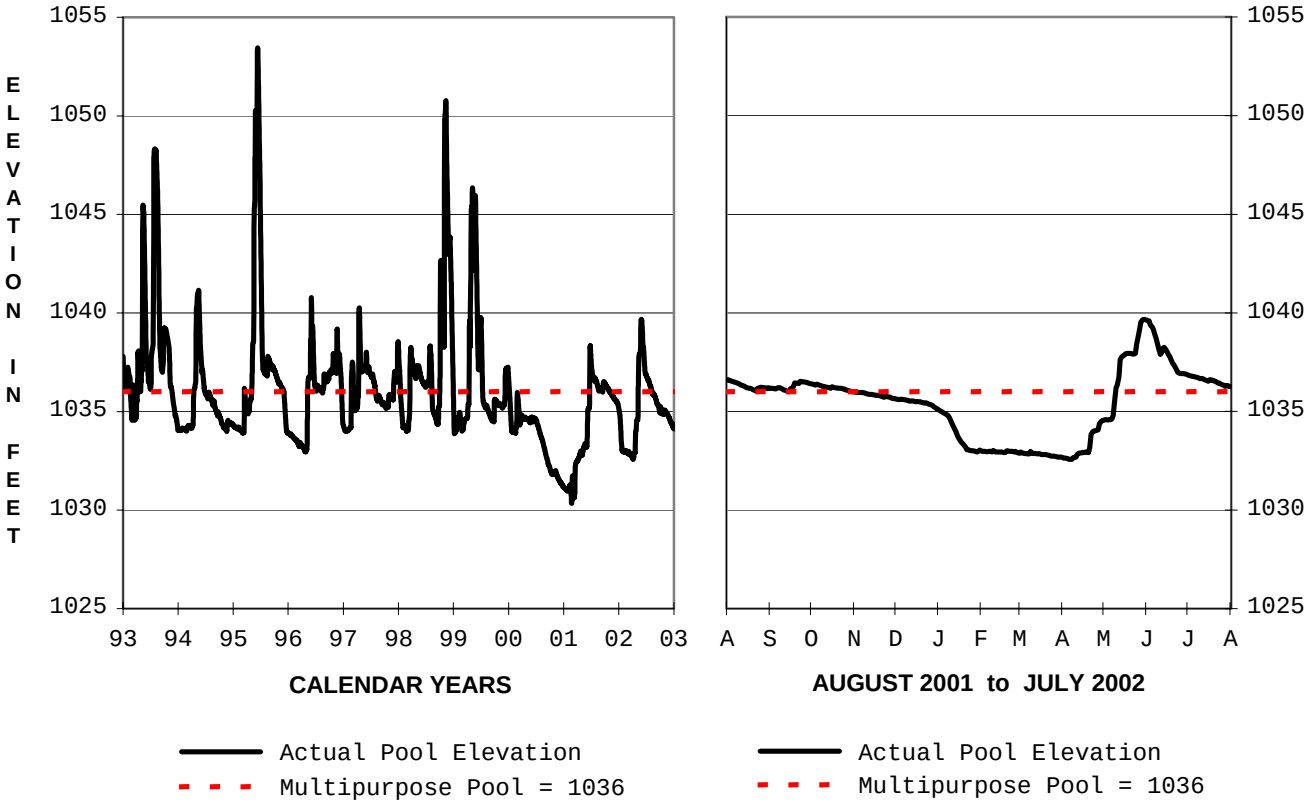



## LONGVIEW LAKE ANNUAL INFLOW



# MELVERN LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

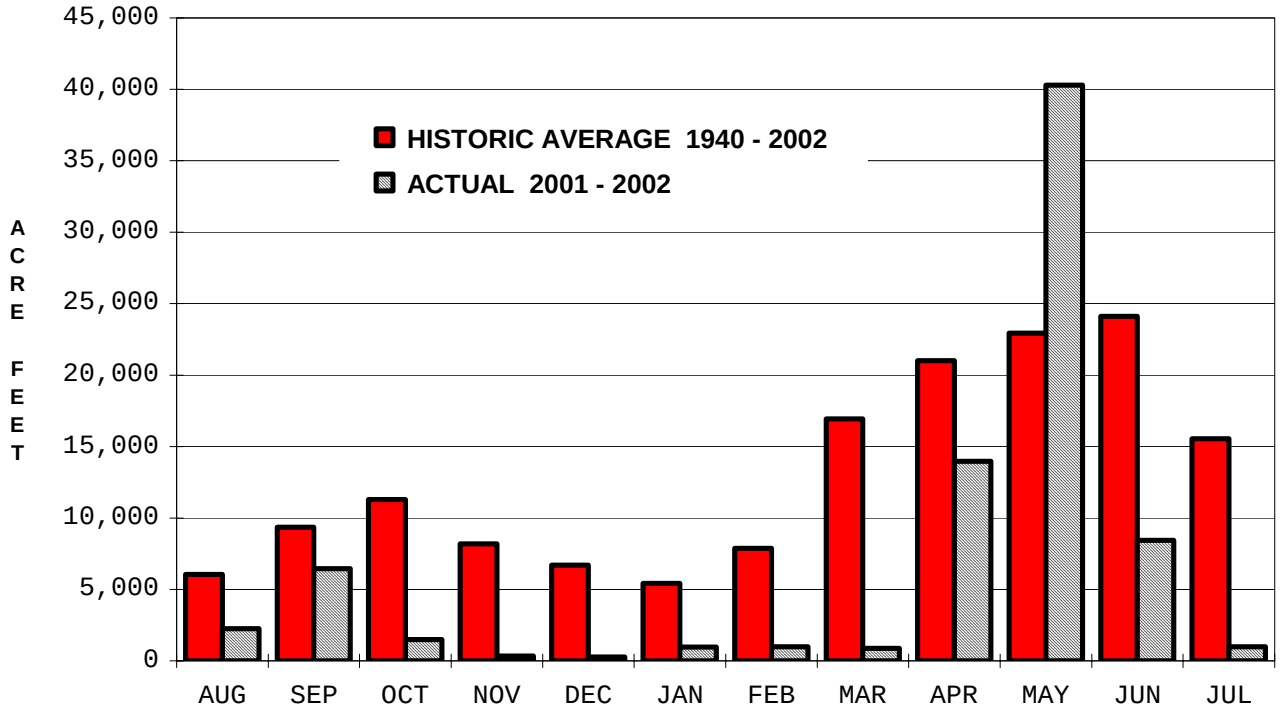



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1036.62<br>1 Aug 01** | **1036.28<br>31 Jul 02** | **1039.67<br>30 May 02** | **1032.55<br>7-8 Apr 02** | **1053.45<br>13 Jun 95** | **1029.87<br>11 Feb 92** |

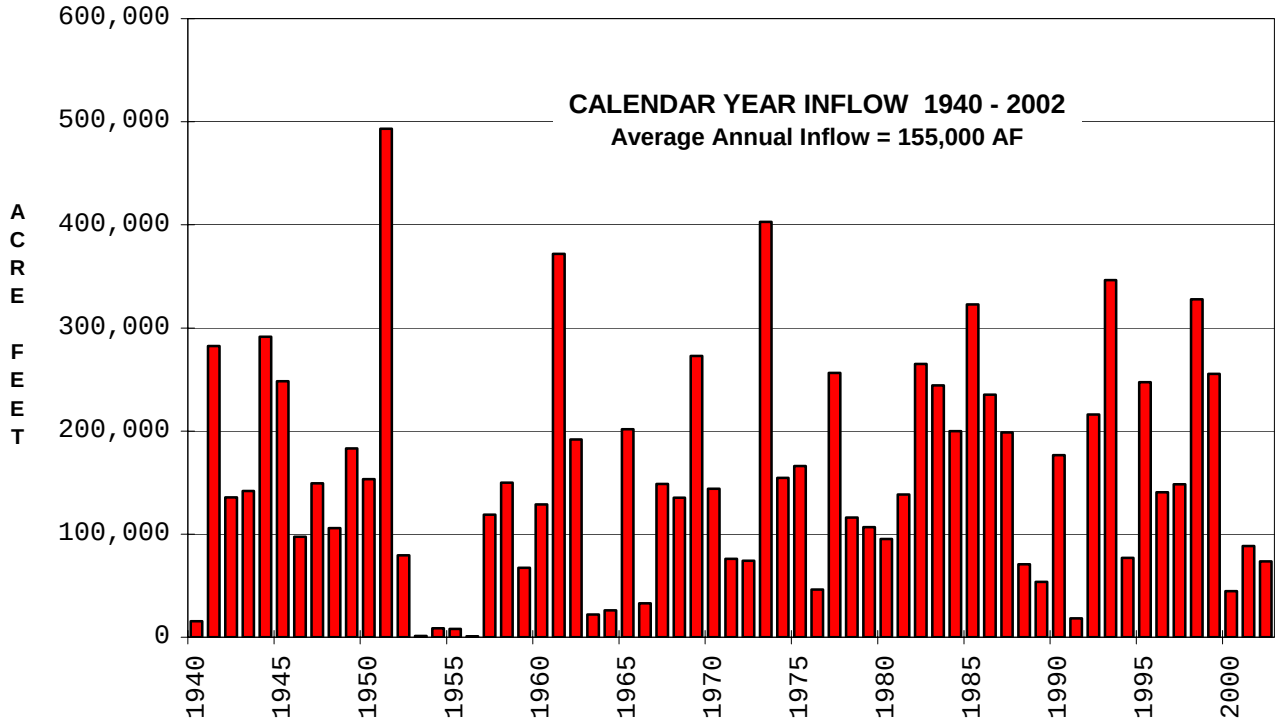
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,270<br>13 May 02** | **77,295 ( 50%)<br>82,194 AF previous period** | **1,000<br>7-11 Jun 02** | **20<br>Most of the year** |

Listed outflows are to river. Minimum required release is 20 cfs. Releases cut to 0 for short maintenance periods.

## MELVERN LAKE MONTHLY INFLOW

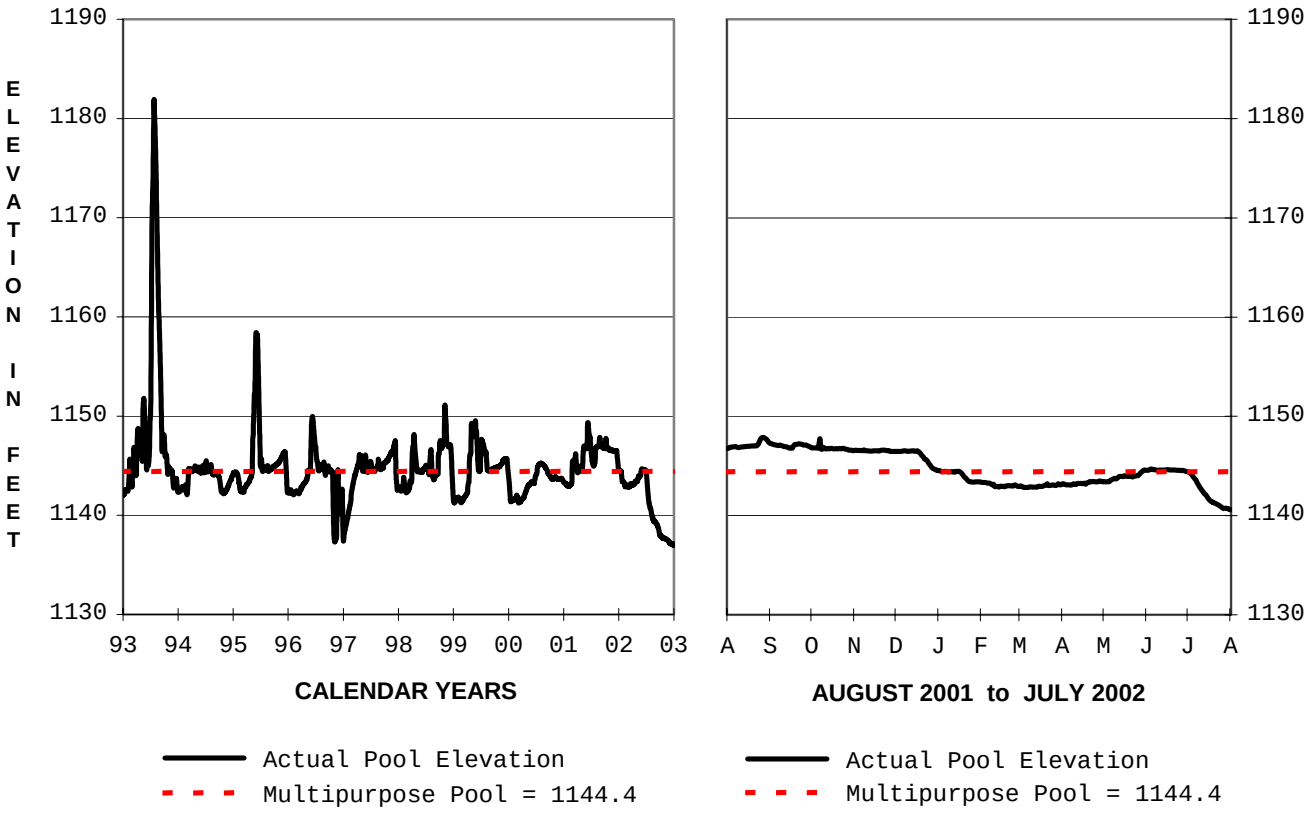



## MELVERN LAKE ANNUAL INFLOW



# MILFORD LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

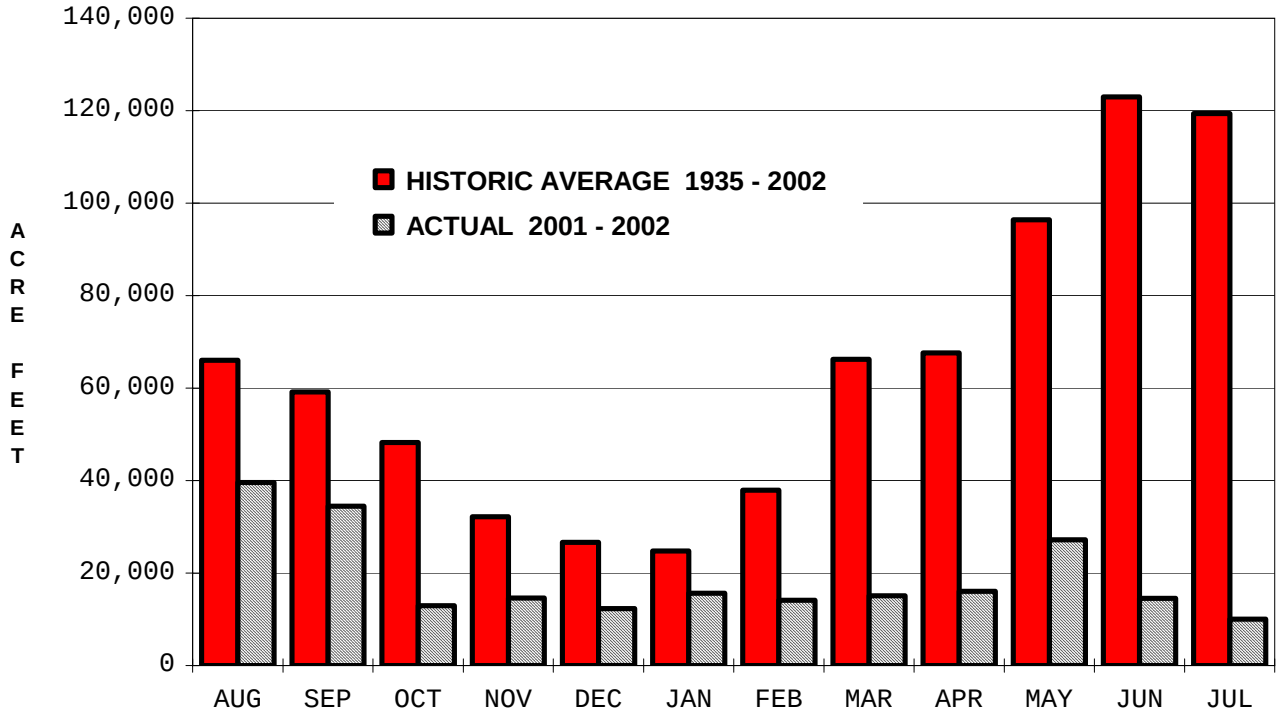



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1146.75<br>1 Aug 01** | **1140.59<br>31 Jul 02** | **1147.89<br>27 Aug 01** | **1140.59<br>31 Jul 02** | **1181.94<br>25 Jul 93** | **1137.30<br>26 Feb 88** |

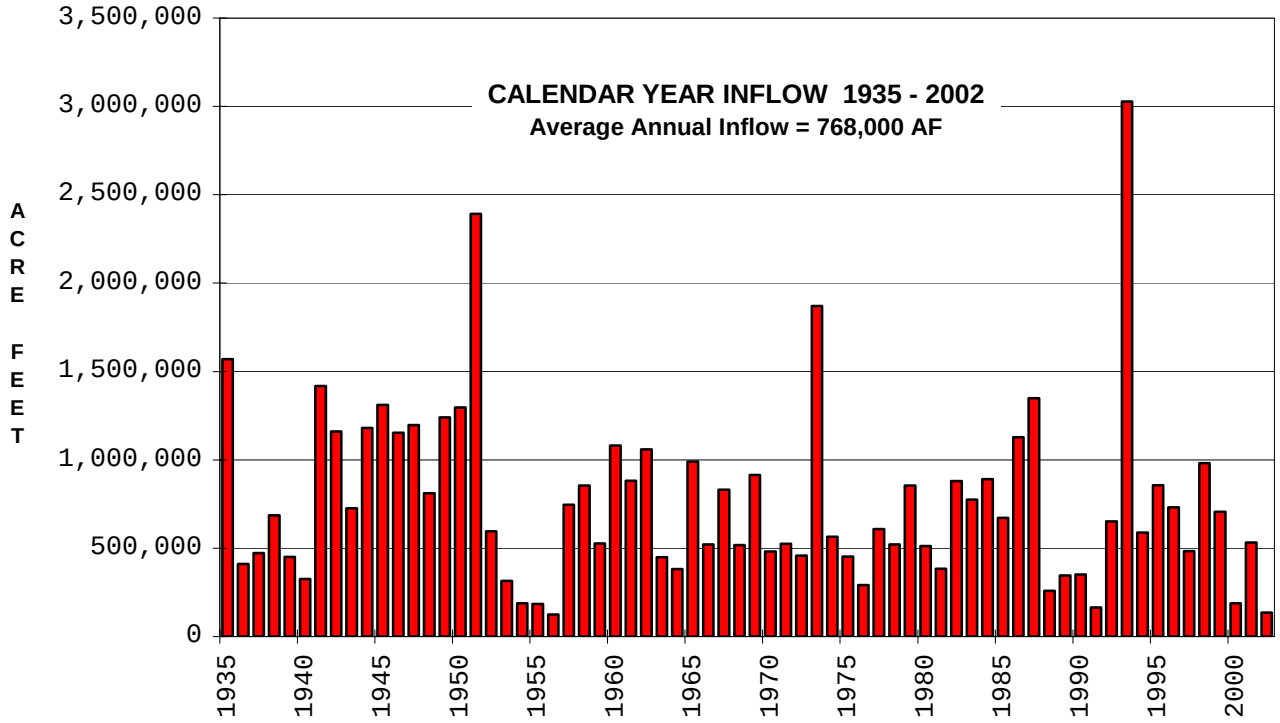
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,000<br>24 Aug 01** | **226,454 ( 30%)<br>456,384 AF previous period** | **2,000<br>31 Aug 01** | **0<br>4 Jun 02** |

All outflows are to the river. Minimum required release is 25 cfs. Releases cut to 0 for short maintenance periods.

## MILFORD LAKE MONTHLY INFLOW

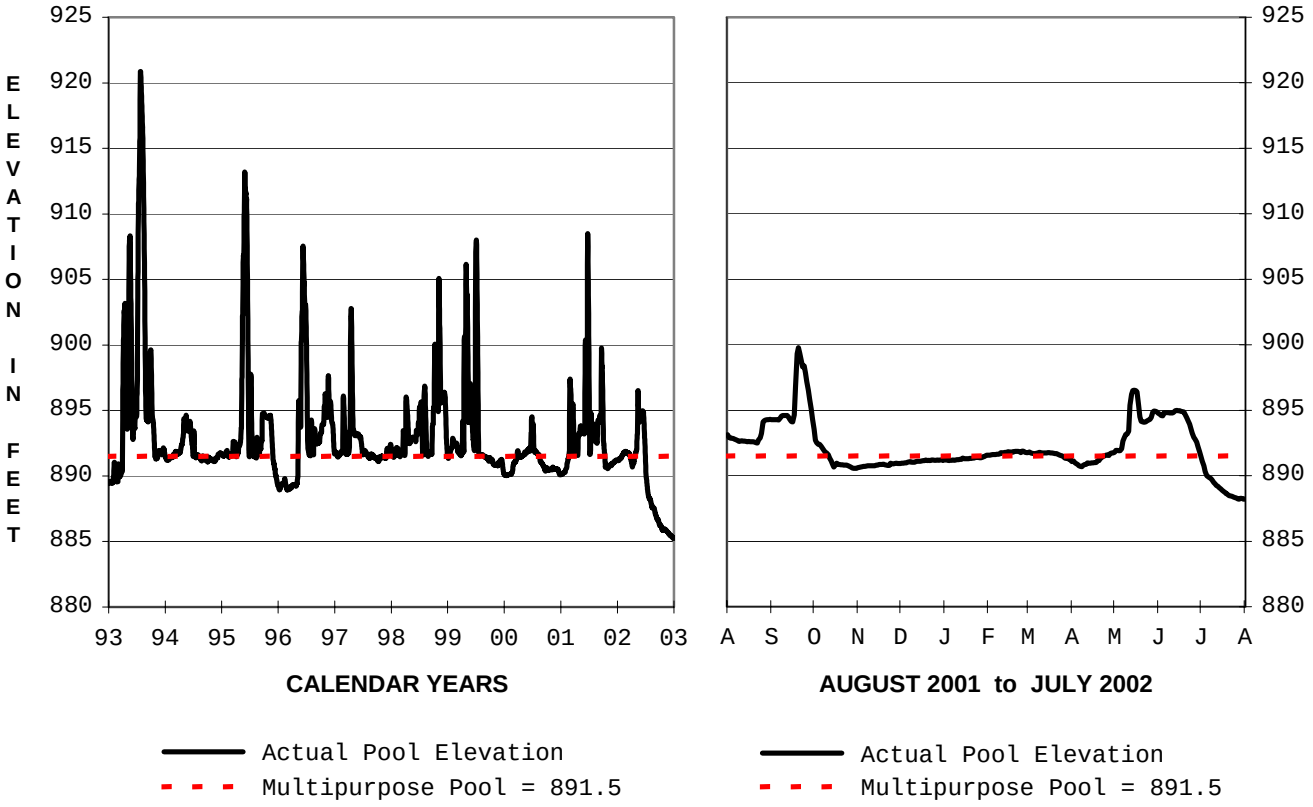



## MILFORD LAKE ANNUAL INFLOW



# PERRY LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

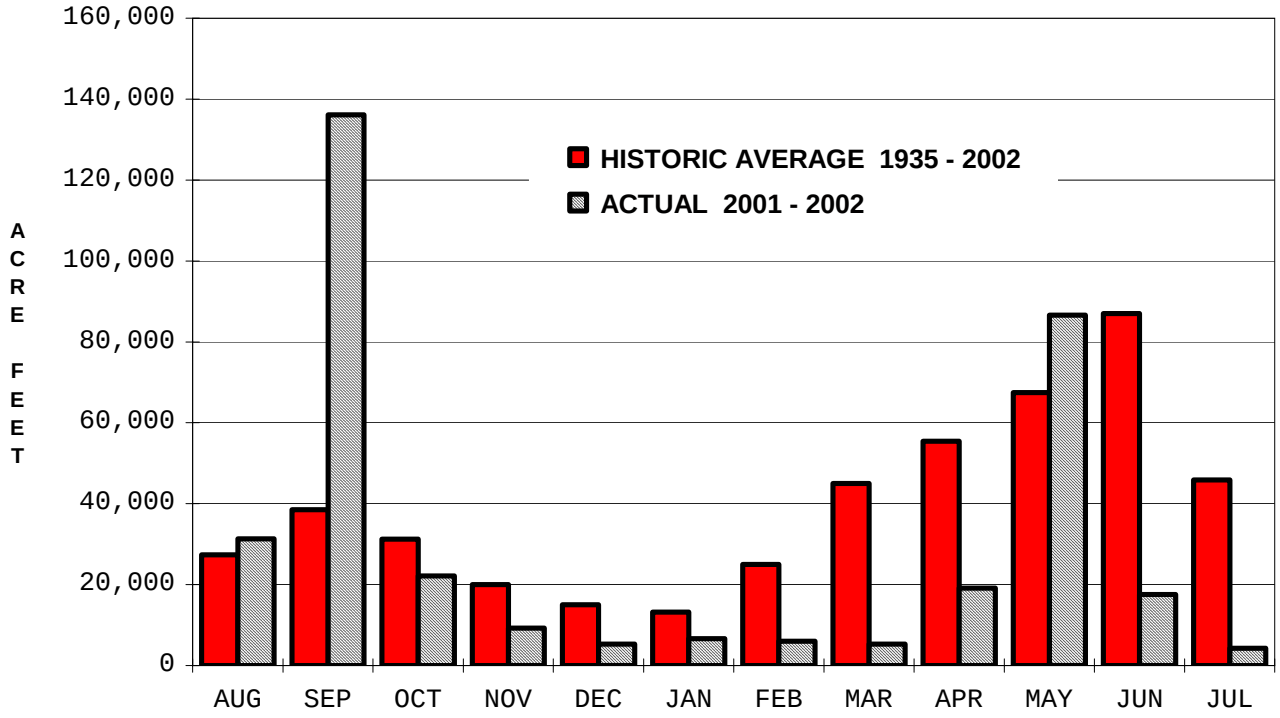



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **893.13<br>1 Aug 01** | **888.25<br>31 Jul 02** | **899.88<br>19 Sep 01** | **888.20<br>28 Jul 02** | **920.85<br>25 Jul 93** | **886.22<br>14 Nov 91** |

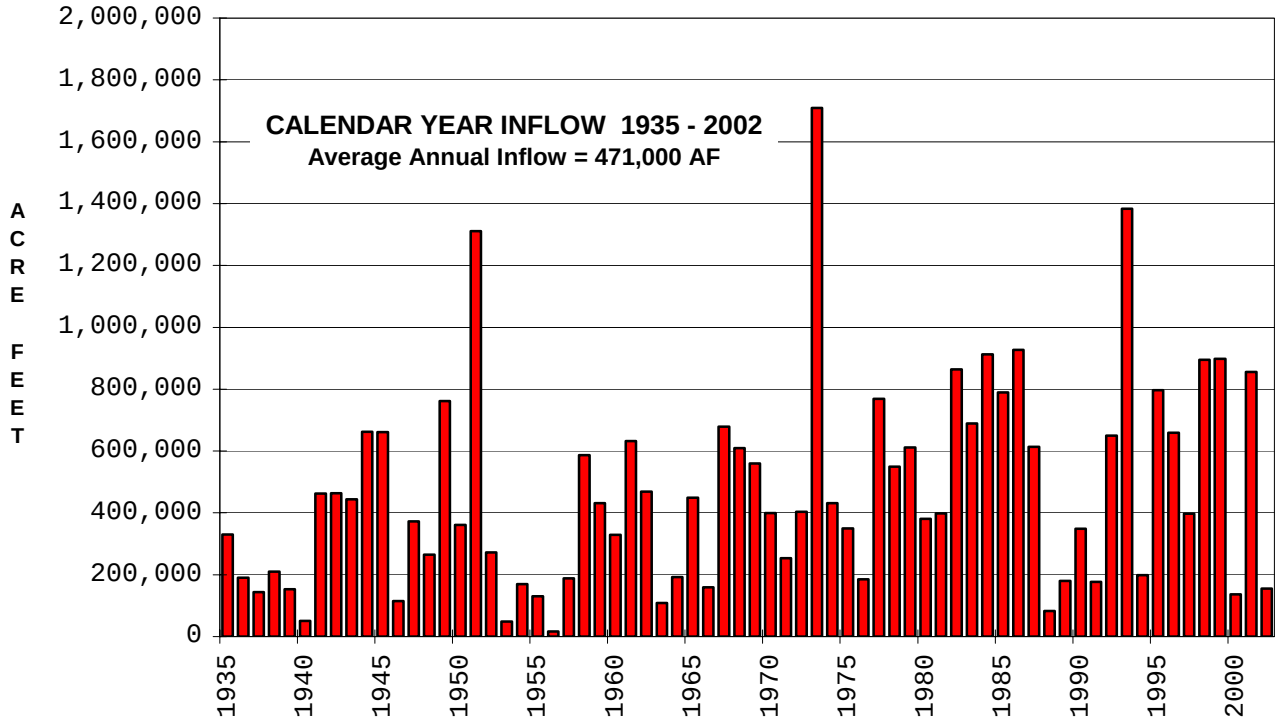
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **20,000<br>18 Sep 01** | **349,674 ( 74%)<br>673,478 AF previous period** | **6,117, 18 May 02<br>For gate test release** | **0, 13-15 Feb 02<br>For gate maintenance** |

All outflows are to the river. Minimum required release is 25 cfs. Releases cut to 0 for short maintenance periods.

## PERRY LAKE MONTHLY INFLOW

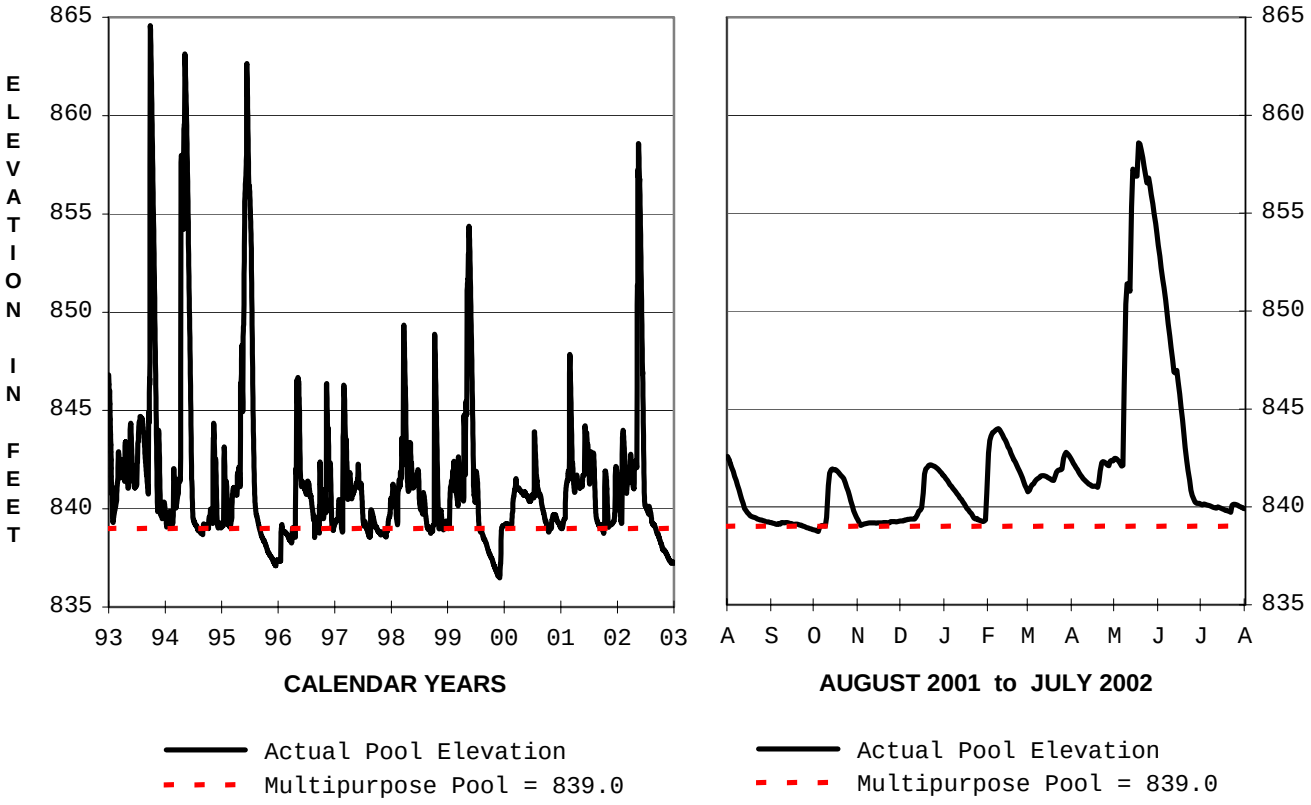



## PERRY LAKE ANNUAL INFLOW



# POMME DE TERRE LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

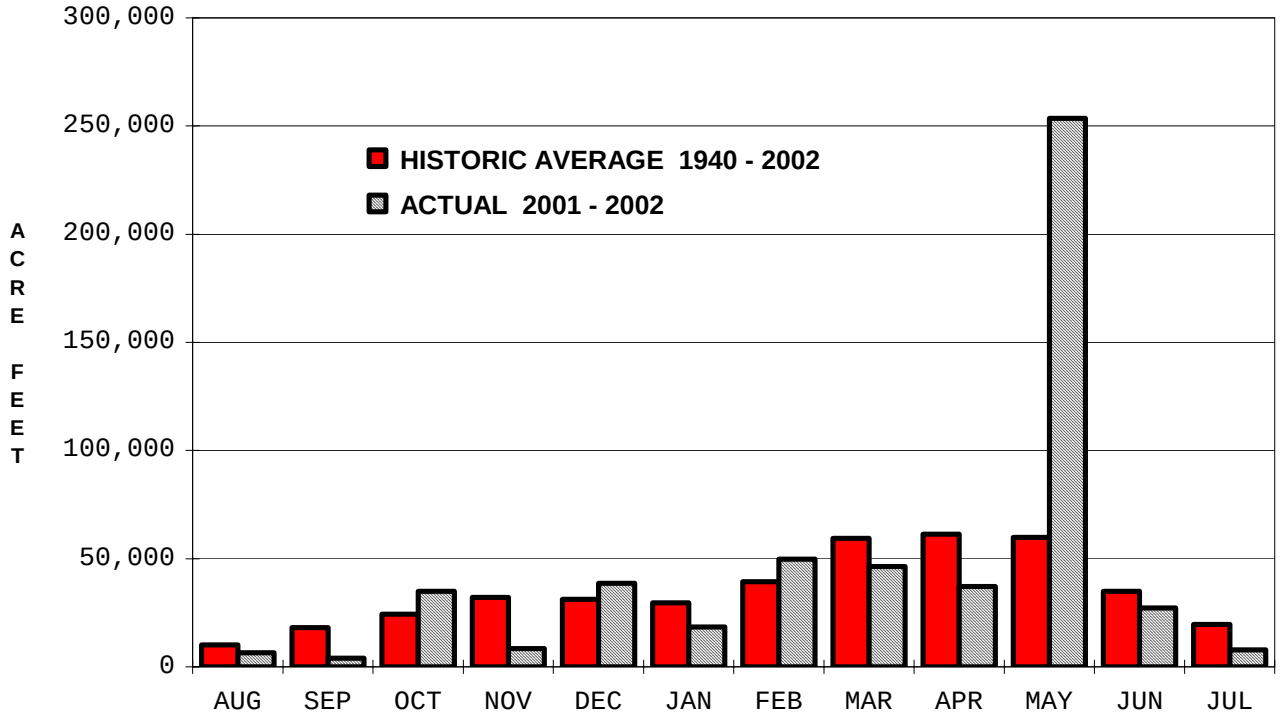



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **842.58<br>1 Aug 01** | **839.94<br>31 Jul 02** | **858.64<br>18 May 02** | **838.73<br>4 Oct 01** | **864.58<br>27 Sep 93** | **835.61<br>3 Mar 64** |

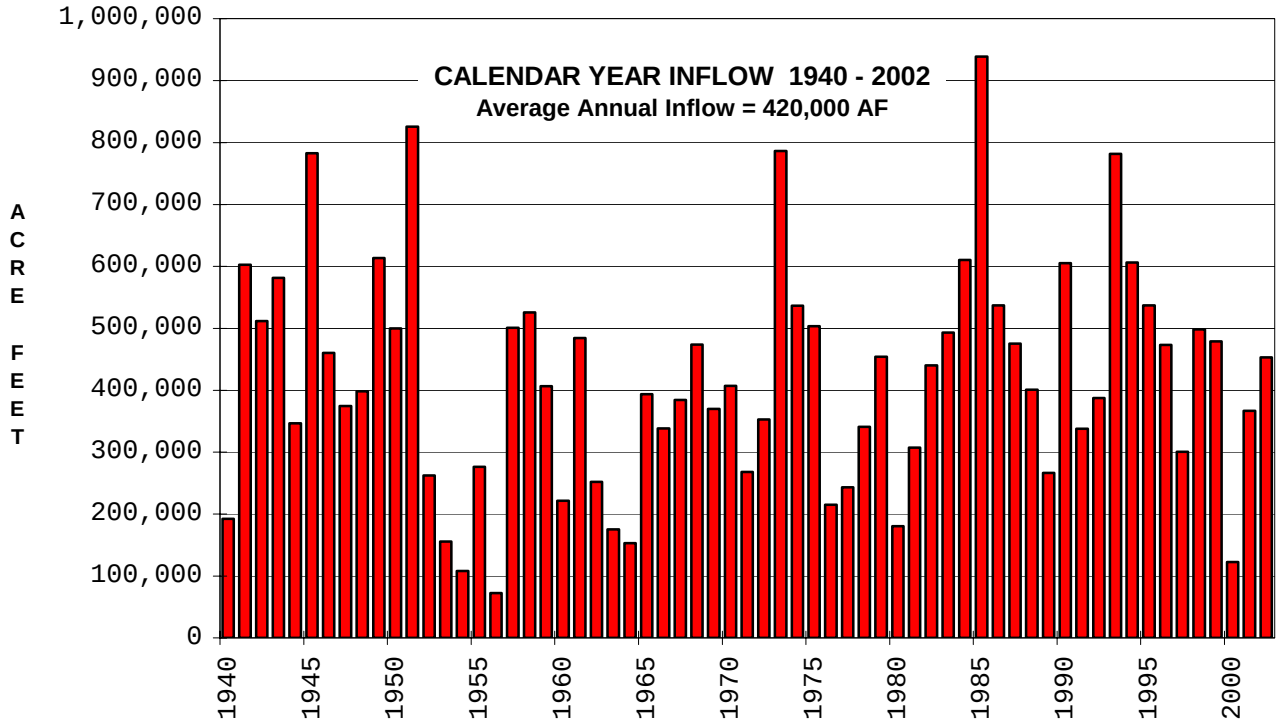
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **25,600<br>13 May 02** | **532,789 ( 127%)<br>300,034 AF previous period** | **3,200<br>20 May to 21 Jun 02** | **0, 5-12 Oct 01 for periodic inspection** |

All outflows are to the river. Minimum required release is 50 to 100 cfs, varying by season and pool level.

## POMME DE TERRE LAKE MONTHLY INFLOW

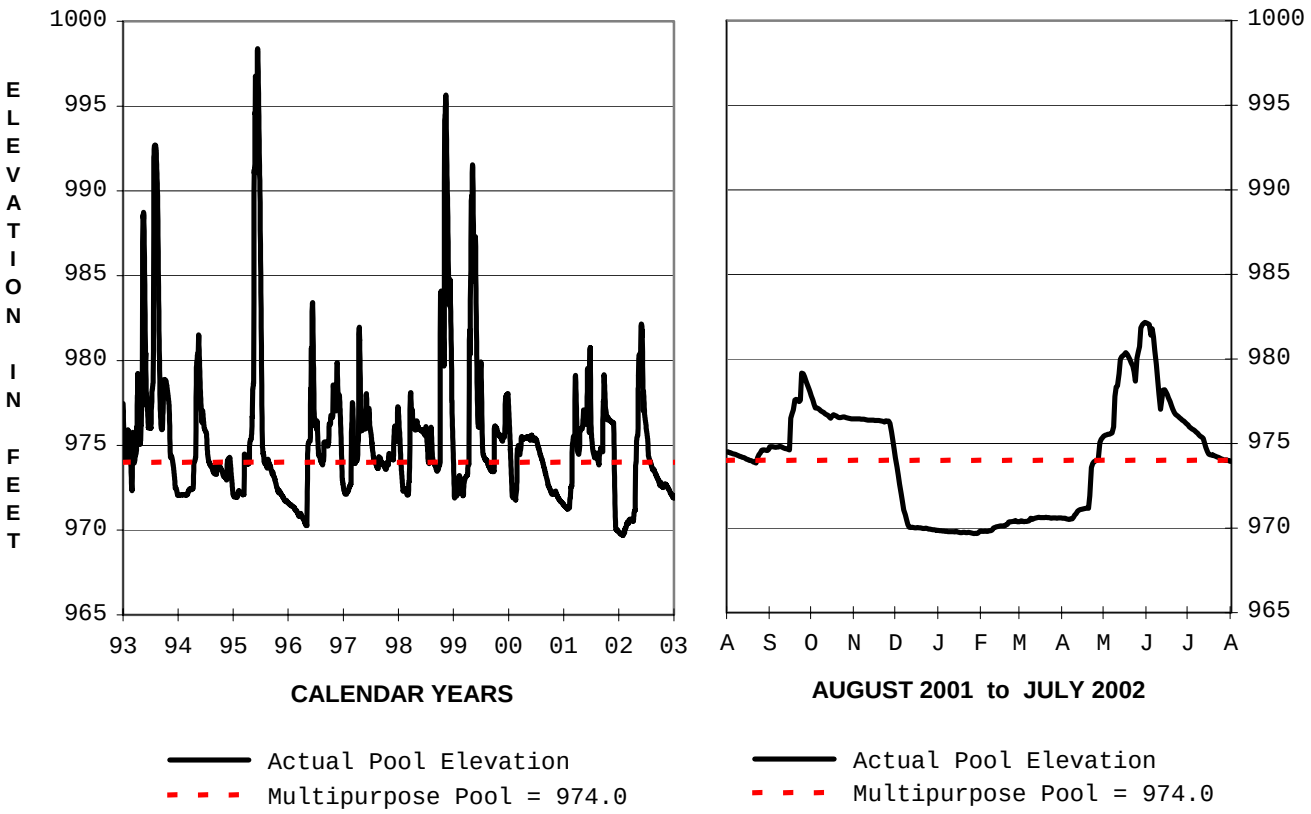



## POMME DE TERRE LAKE ANNUAL INFLOW



# POMONA LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

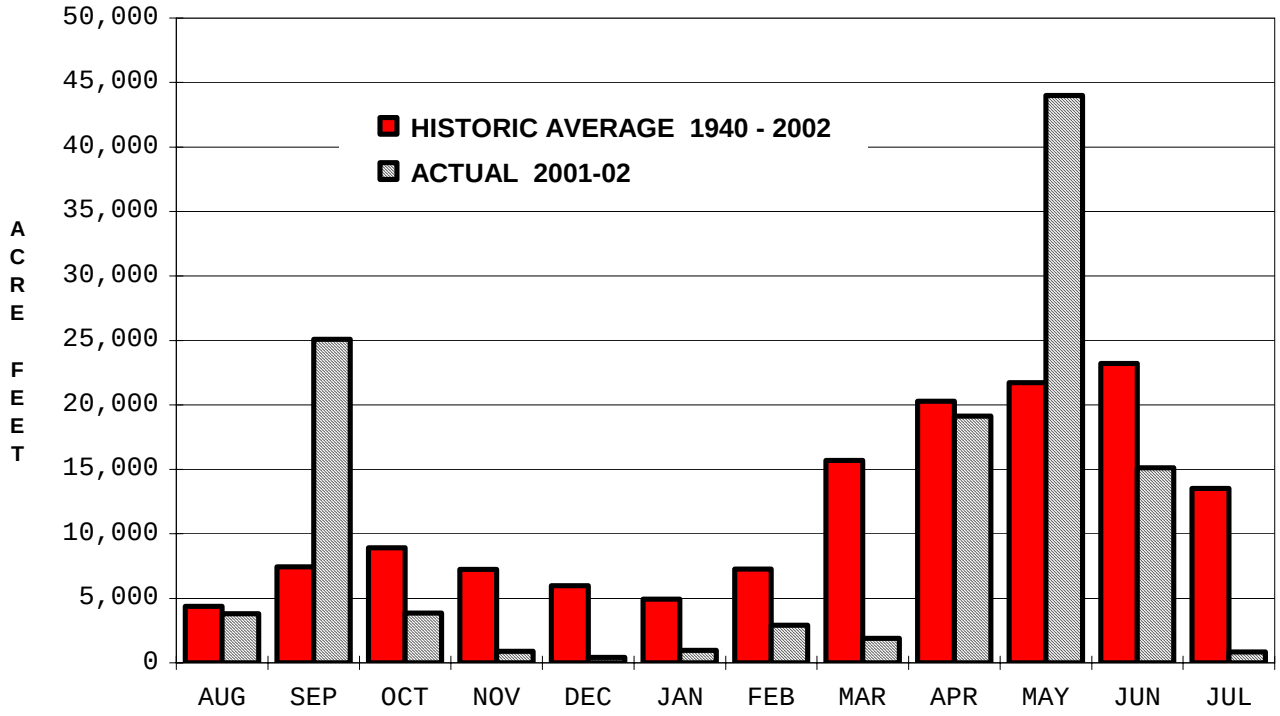



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **974.51<br>1 Aug 01** | **973.97<br>31 Jul 02** | **982.15<br>31 May 02** | **969.66<br>27 Jan 02** | **998.40<br>12-13 Jun 95** | **969.62<br>30 Mar 67** |

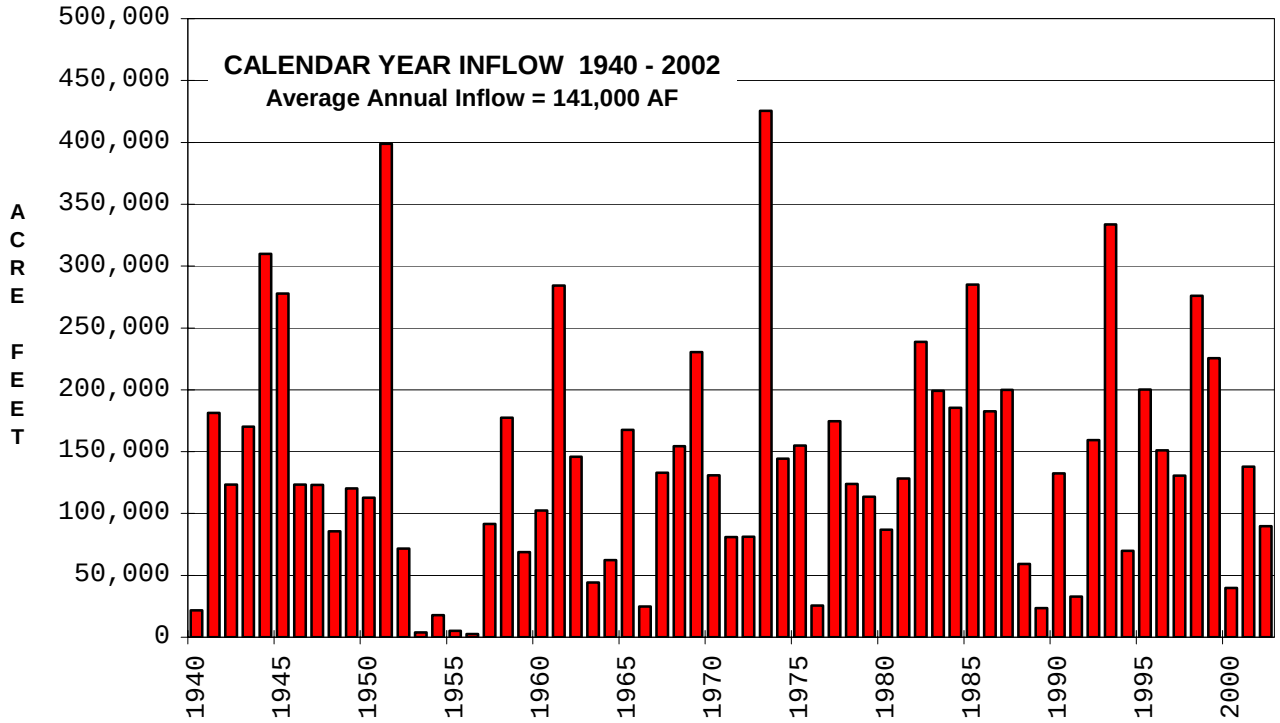
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,900<br>16 Sep 01** | **118,927 ( 85%)<br>107,315 AF previous period** | **2,000<br>7-11 Jun 02** | **0<br>23-25 Oct 01** |

All outflows are to the river. Minimum required release is 15 cfs. Releases cut to 0 for short maintenance periods. Lake lowered to 970.00 in December 2001 for maintenance work on embankment.

## POMONA LAKE MONTHLY INFLOW

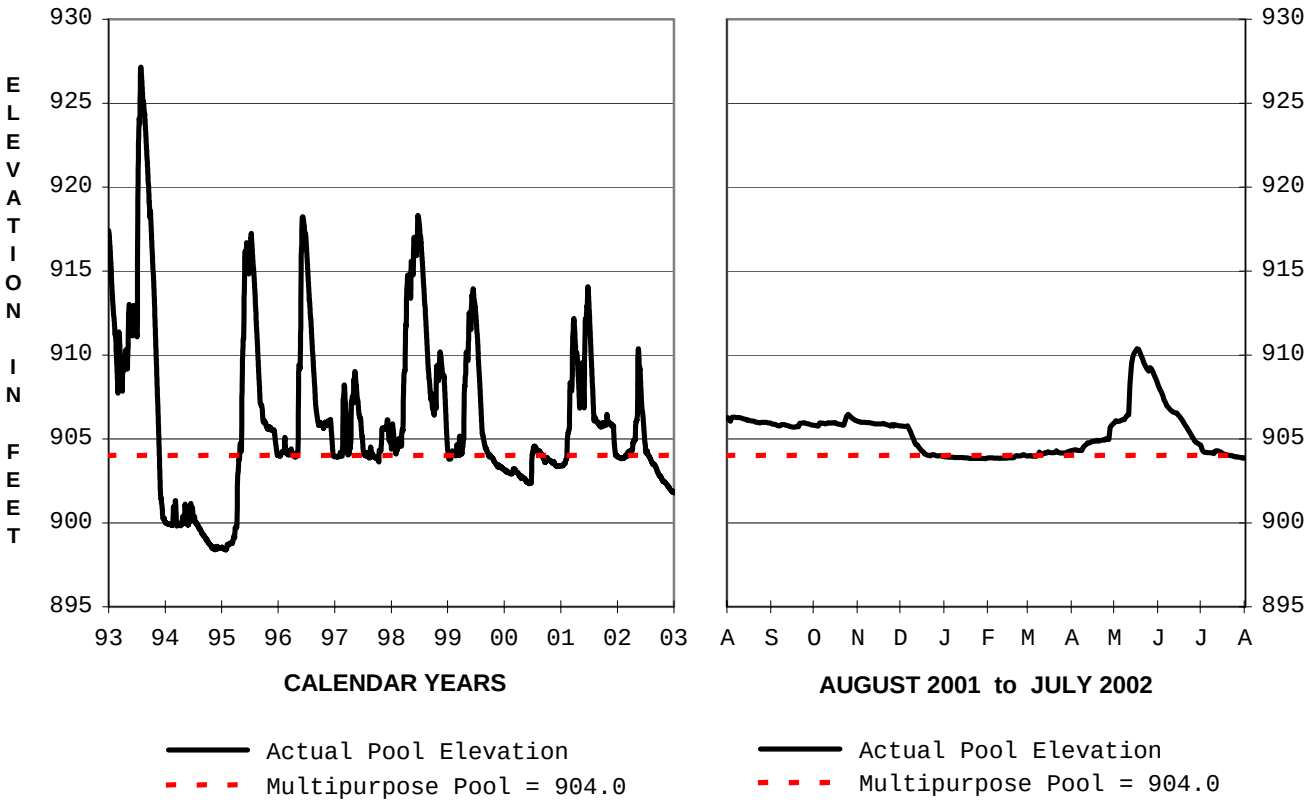



## POMOMA LAKE ANNUAL INFLOW



# RATHBUN LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

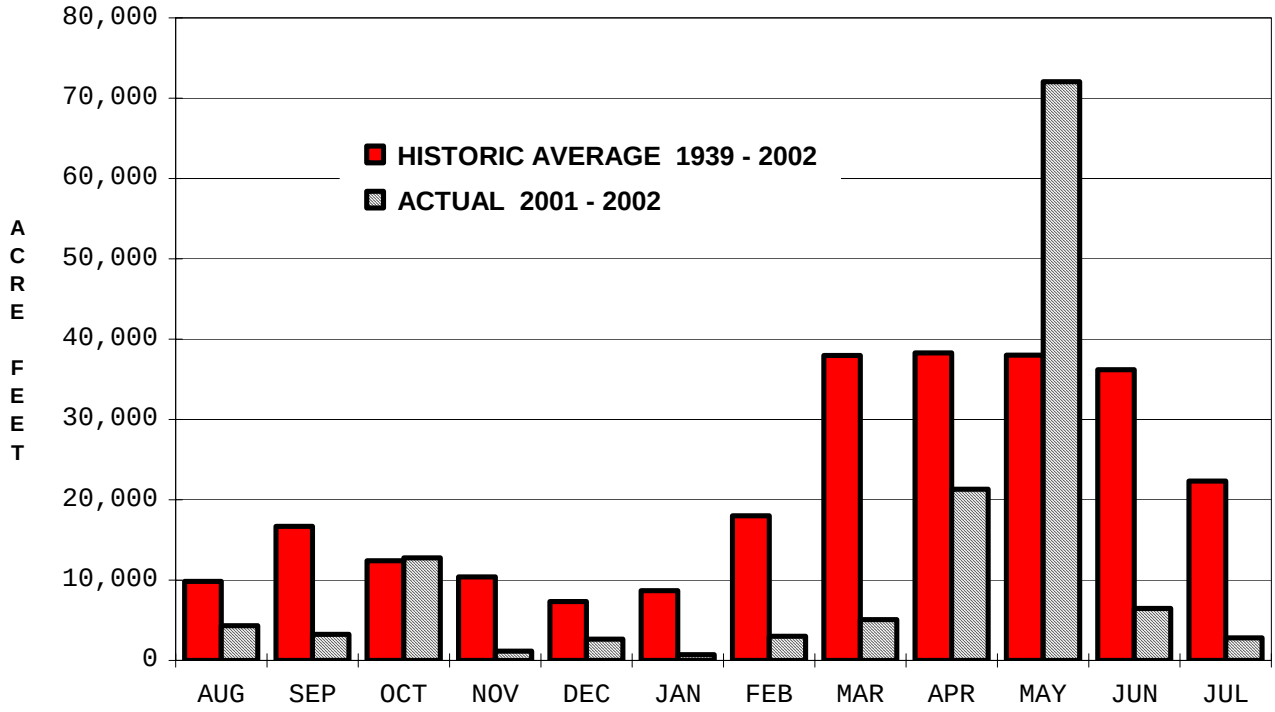



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **906.27<br>1 Aug 01** | **903.87<br>31 Jul 02** | **910.41<br>17 May 02** | **903.82<br>27-30 Jan 02** | **927.16<br>28 Jul 93** | **898.38<br>26-27 Jan 95** |

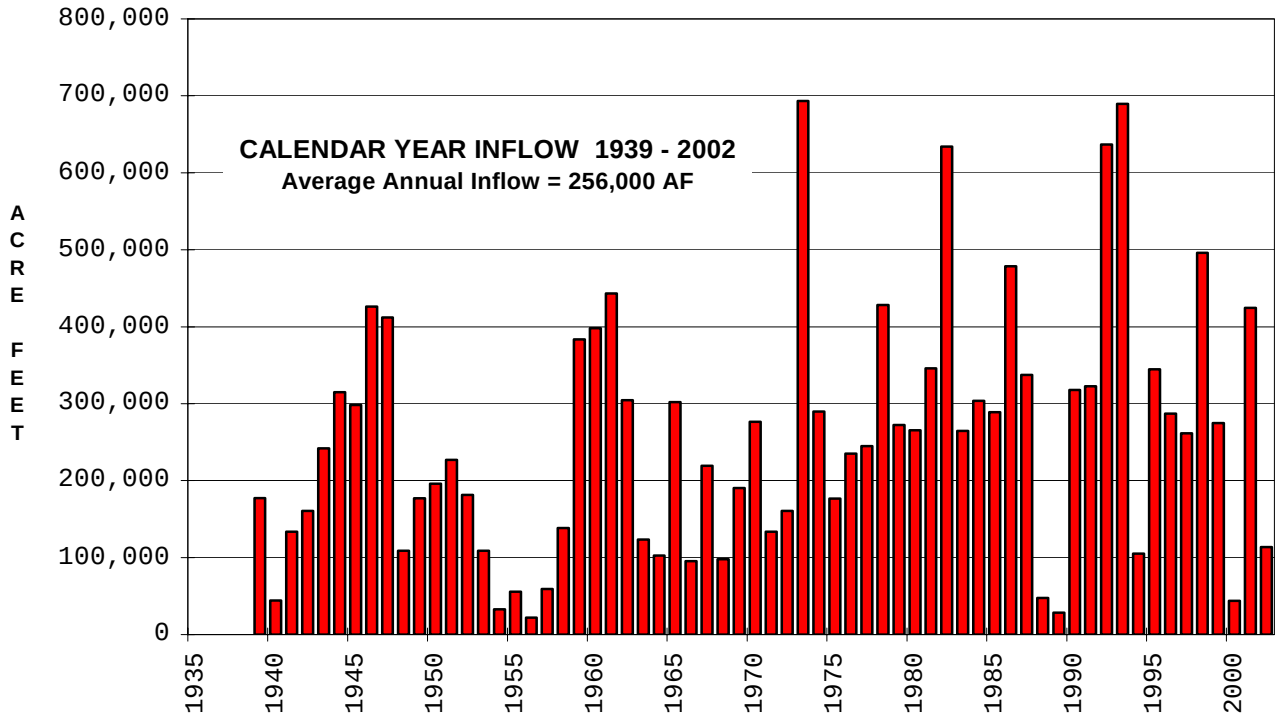
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **11,000<br>12 May 02** | **135,651 ( 53%)<br>410,537 AF previous period** | **1,510 19-25 May 02<br>28 May to 5 Jun 02** | **18<br>4-10 Aug 01** |

All outflows to the river. Outlets include a fish hatchery pipe and service gate. Minimum release varies 15-30 cfs.

## RATHBUN LAKE MONTHLY INFLOW

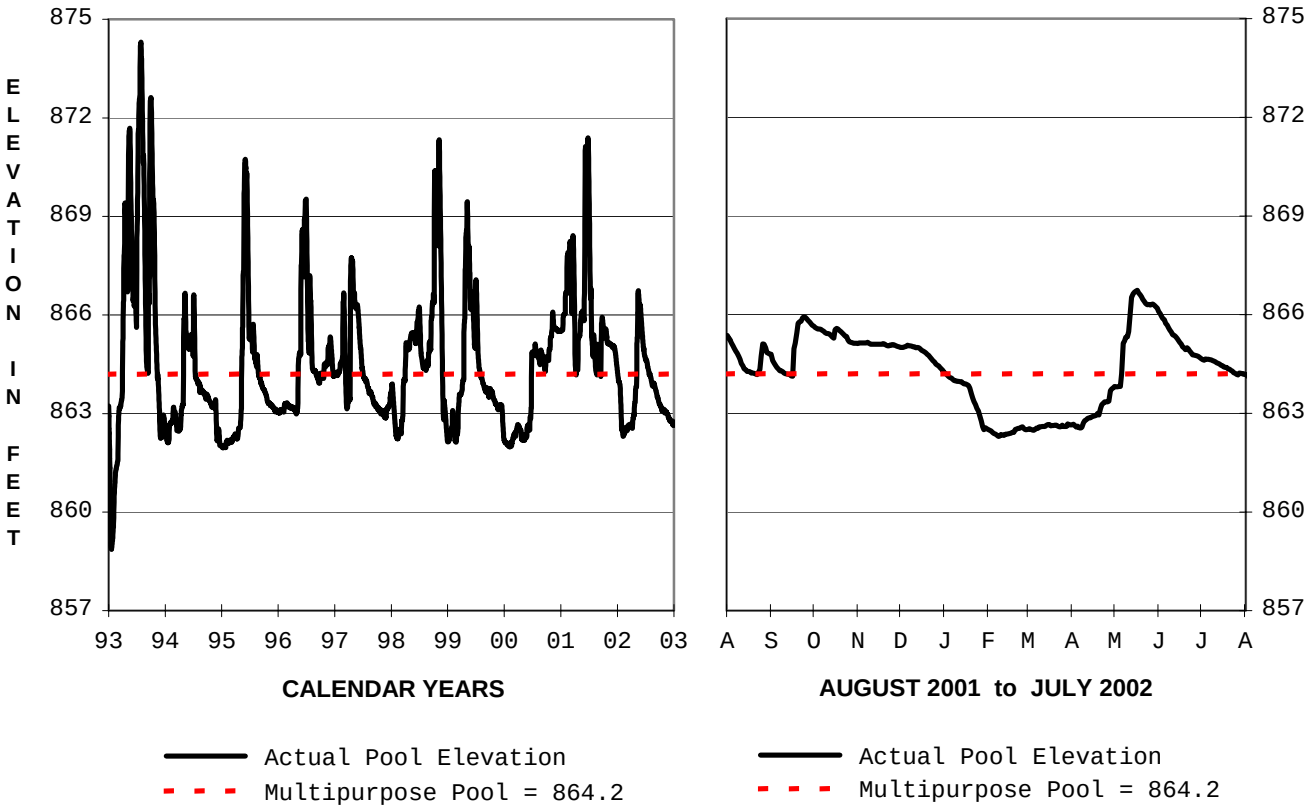



## RATHBUN LAKE ANNUAL INFLOW



# SMITHVILLE LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

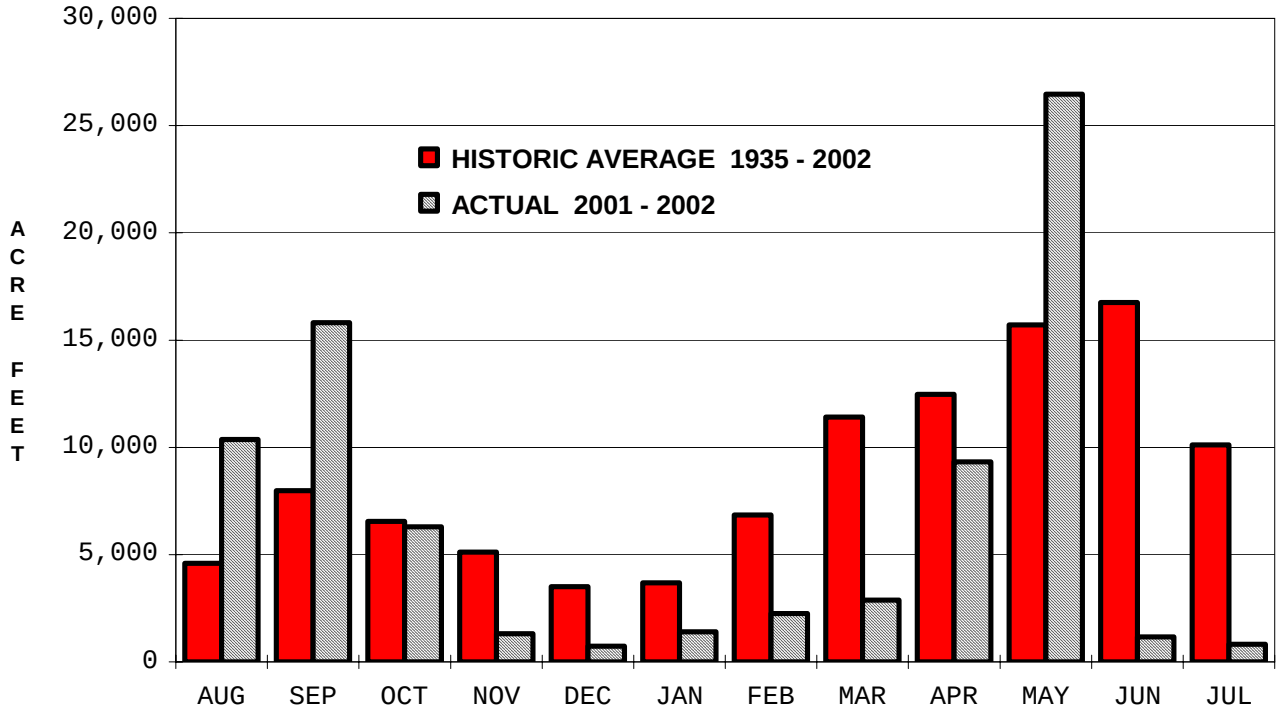



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **865.37<br>1 Aug 01** | **864.20<br>31 Jul 02** | **866.75<br>17 May 02** | **862.30<br>8 Feb 02** | **874.31<br>27-28 Jul 93** | **858.86<br>19 Jan 93** |

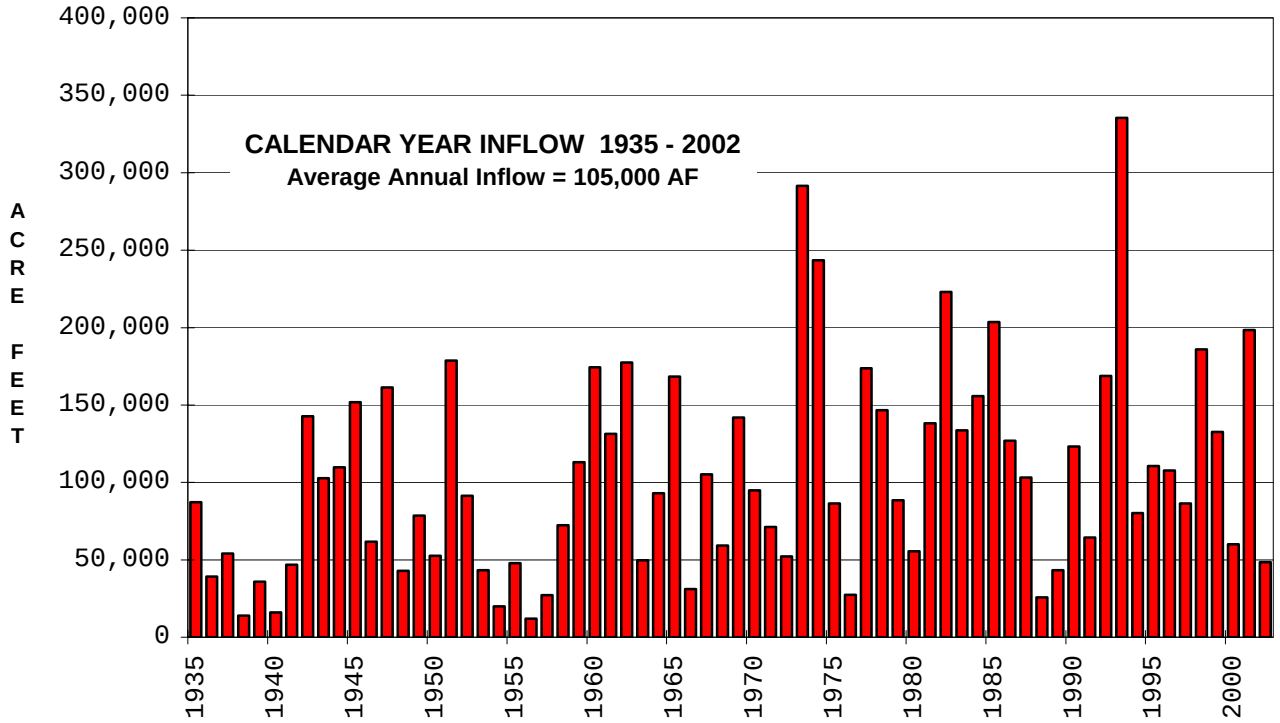
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **3,300<br>7 May 02** | **78,842 ( 75%)<br>187,623 AF previous period** | **500 29-31 Aug 01<br>20-28 Jan 02** | **0, 18-19 Sep 01<br>9-10 May 02** |

Listed outflows are to river. Min required release is 8 cfs. Releases cut to 0 during flooding and for maintenance.

## SMITHVILLE LAKE MONTHLY INFLOW

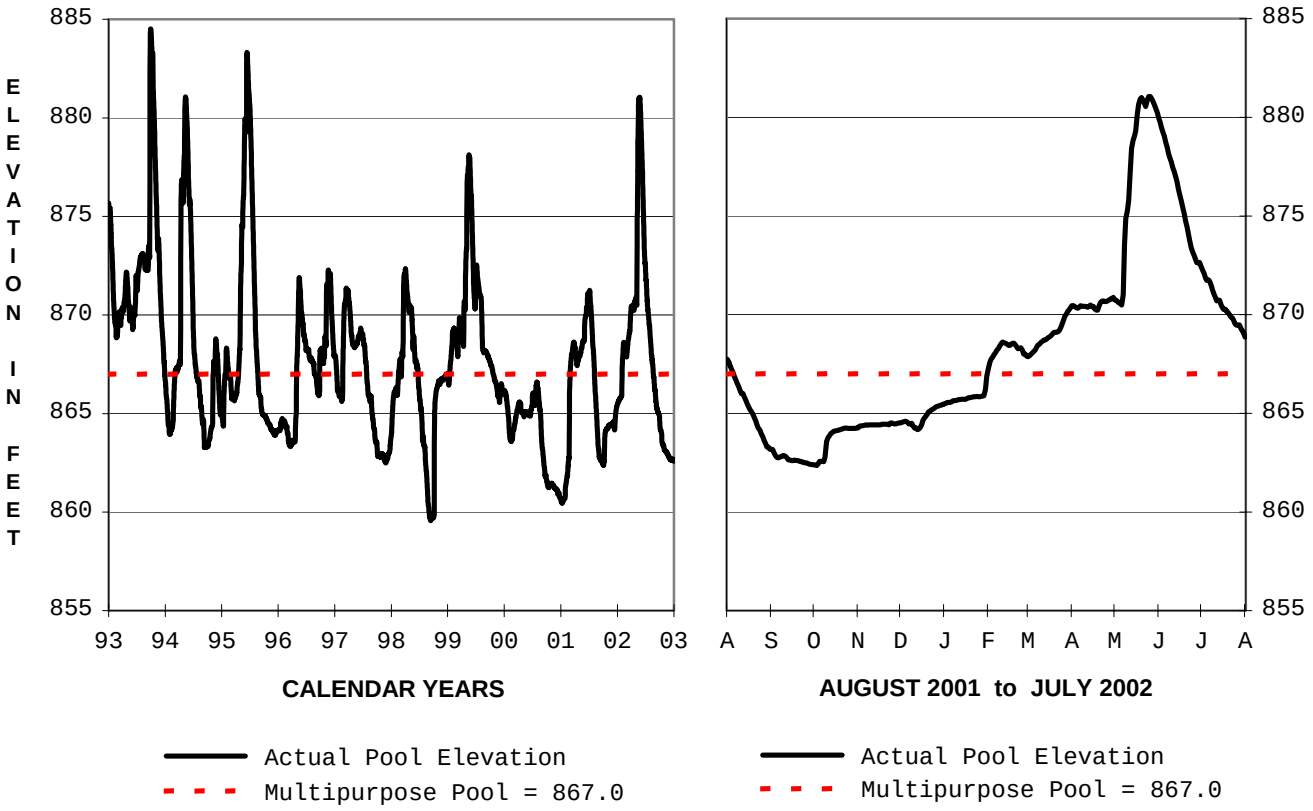



## SMITHVILLE LAKE ANNUAL INFLOW



# STOCKTON LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

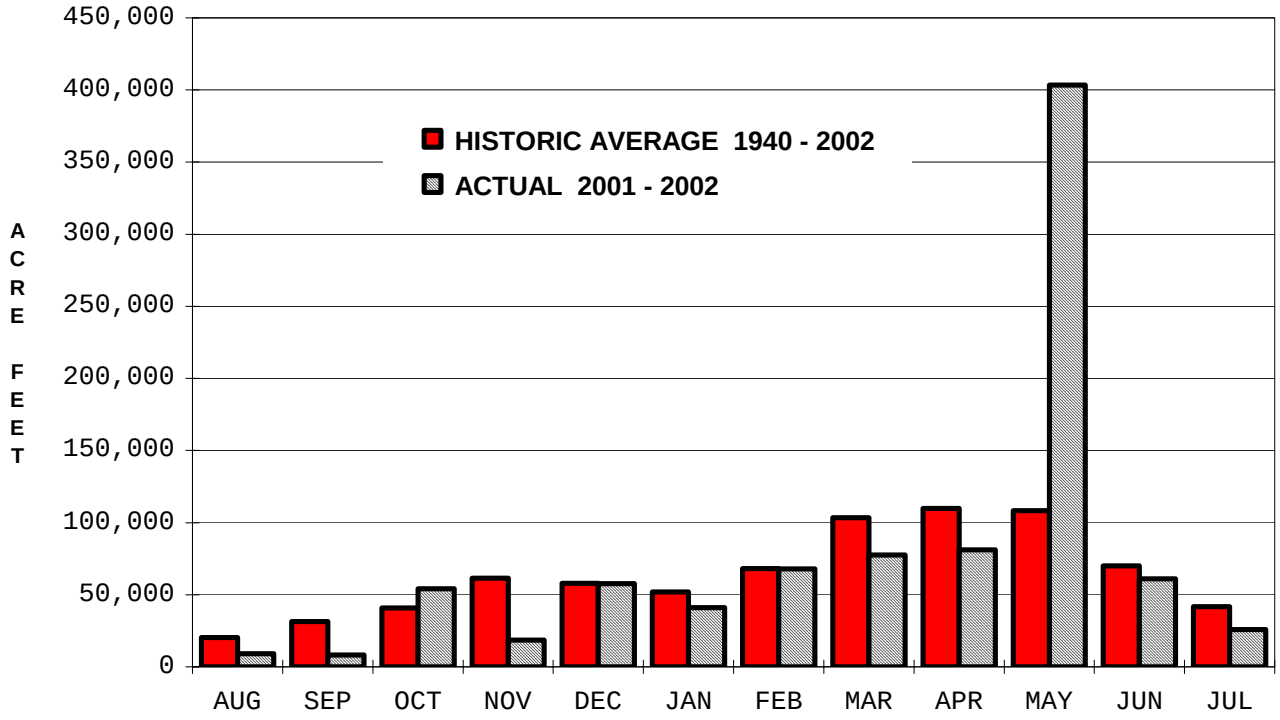



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **867.75<br>1 Aug 01** | **869.07<br>31 Jul 02** | **881.12<br>26 May 02** | **862.35<br>4 Oct 01** | **885.94<br>28 Apr 73** | **851.86<br>2 Feb 77** |

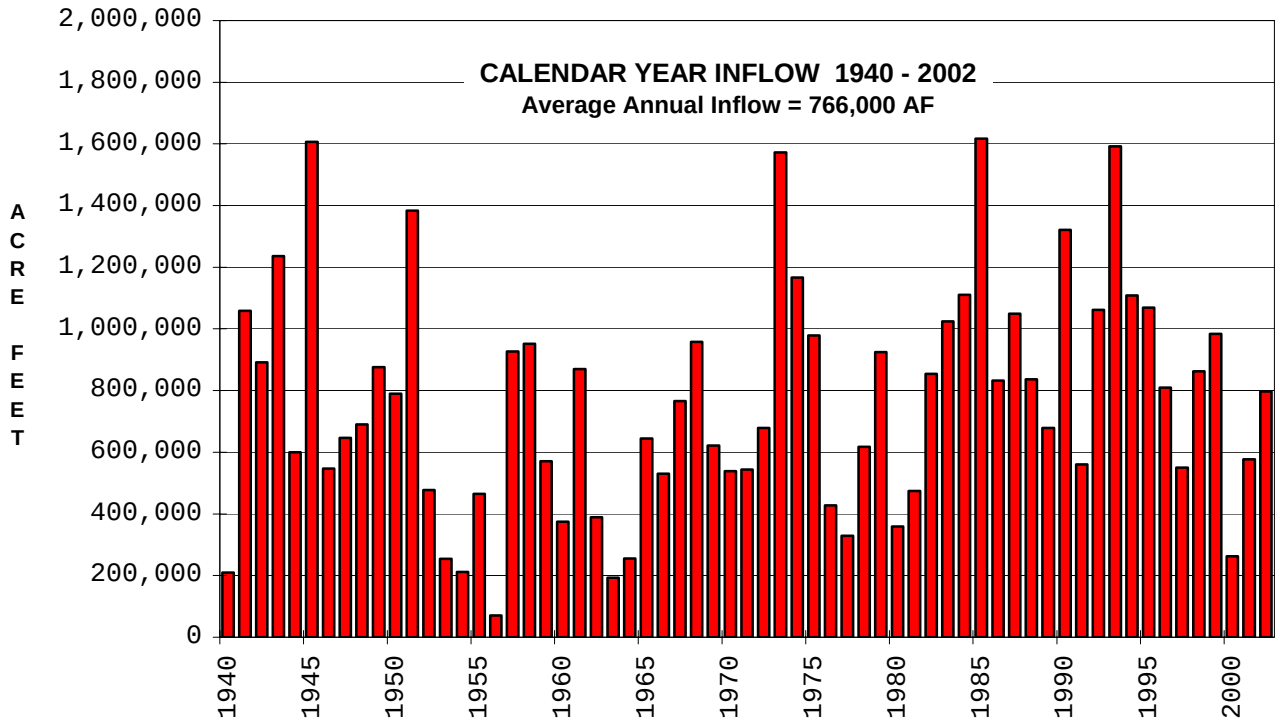
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **35,000<br>8 May 02** | **905,752 ( 118%)<br>485,561 AF previous period** | **5,426<br>24 Jun 02** | **40<br>Frequently** |

Listed outflows include turbine releases and spill to the river. 40 cfs spill required when not generating.

## STOCKTON LAKE MONTHLY INFLOW

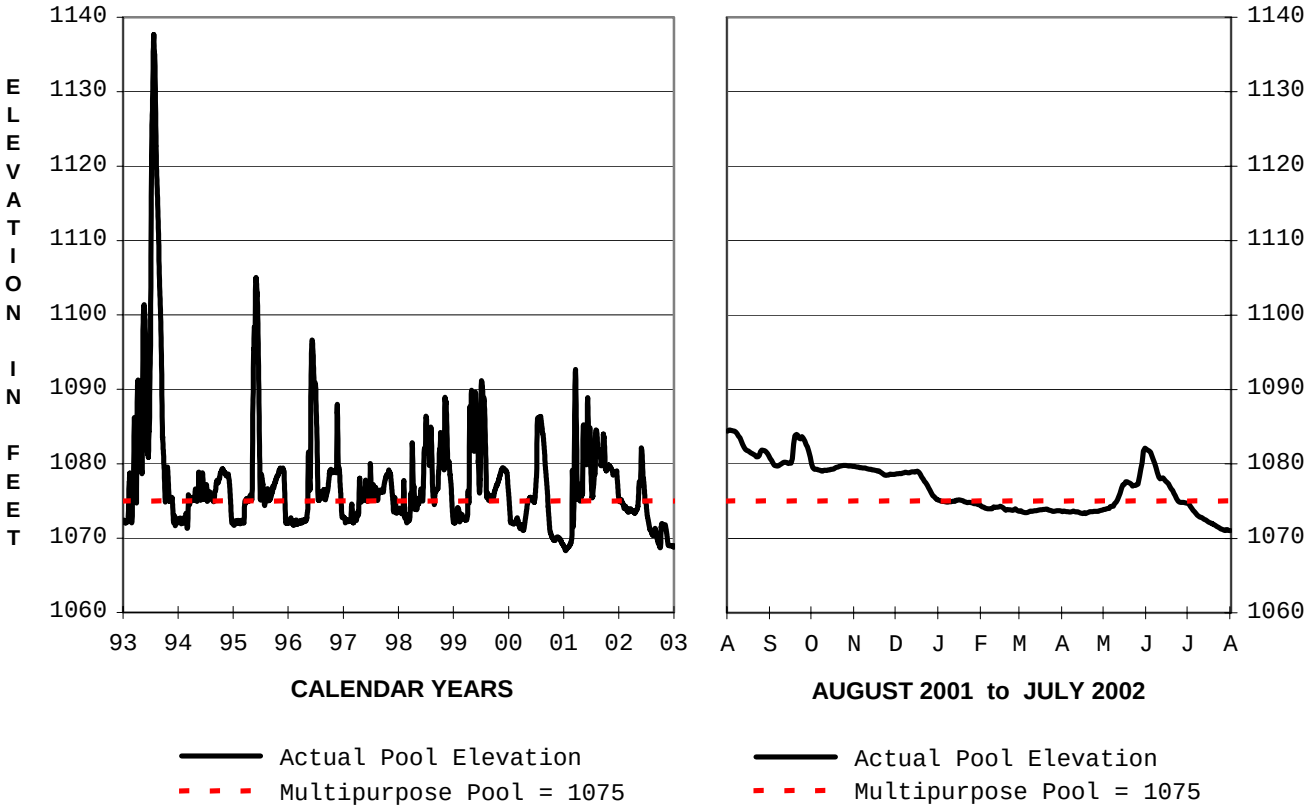



## STOCKTON LAKE ANNUAL INFLOW



# TUTTLE CREEK LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

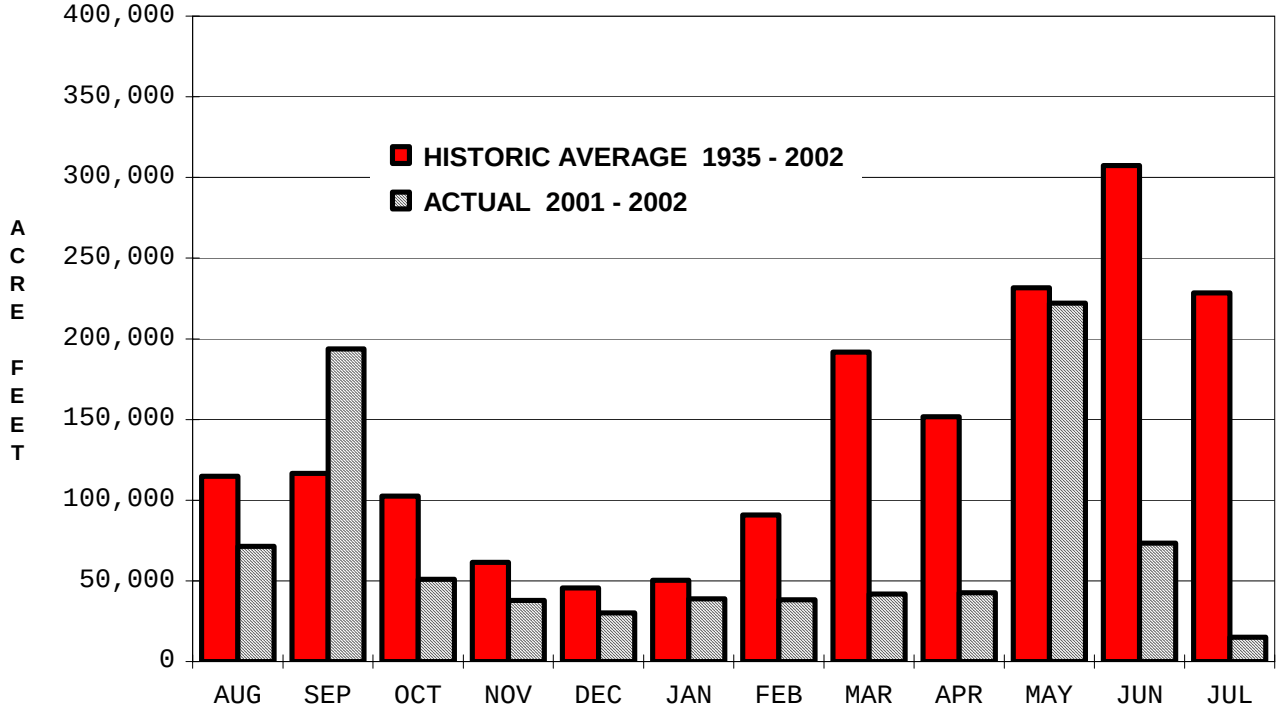



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1084.38<br>1 Aug 01** | **1071.04<br>31 Jul 02** | **1084.55<br>3 Aug 01** | **1071.04<br>31 Jul 02** | **1137.77<br>22 Jul 93** | **1060.82<br>4 Jan 67** |

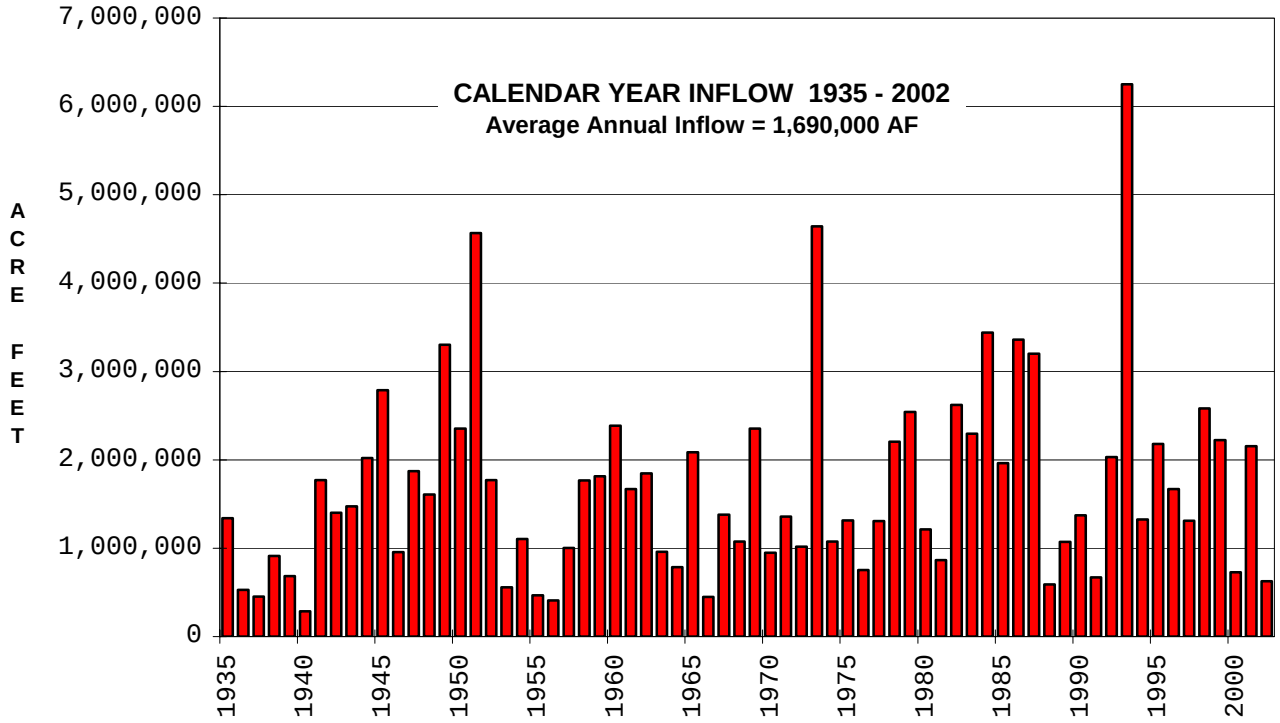
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **19,500<br>30 May 02** | **856,322 ( 51%)<br>1,929,797 AF previous period** | **8,000<br>30 Sep 01** | **158<br>10 May 02** |

All outflows are to the river. Minimum release is 50 to 100 cfs. Releases cut to 0 for short maintenance periods.

## TUTTLE CREEK LAKE MONTHLY INFLOW

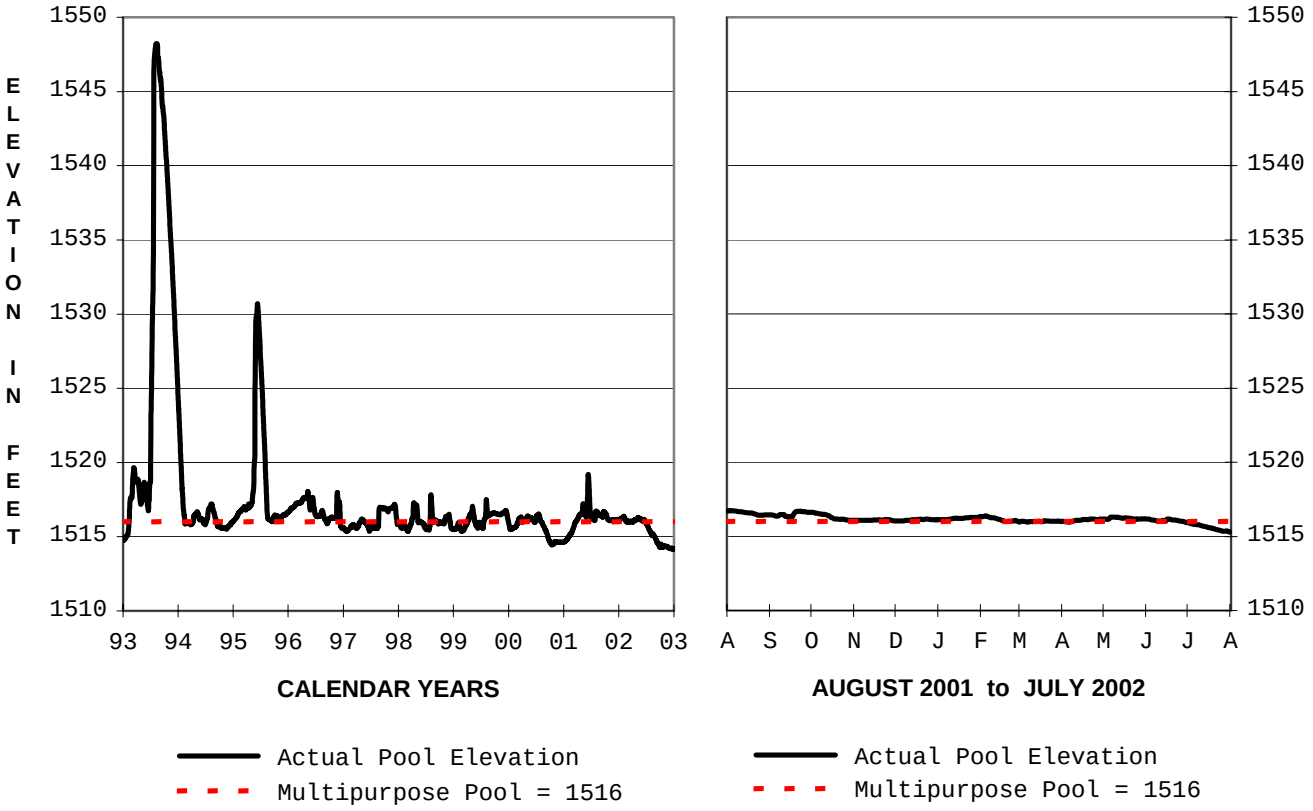



## TUTTLE CREEK LAKE ANNUAL INFLOW



# WILSON LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

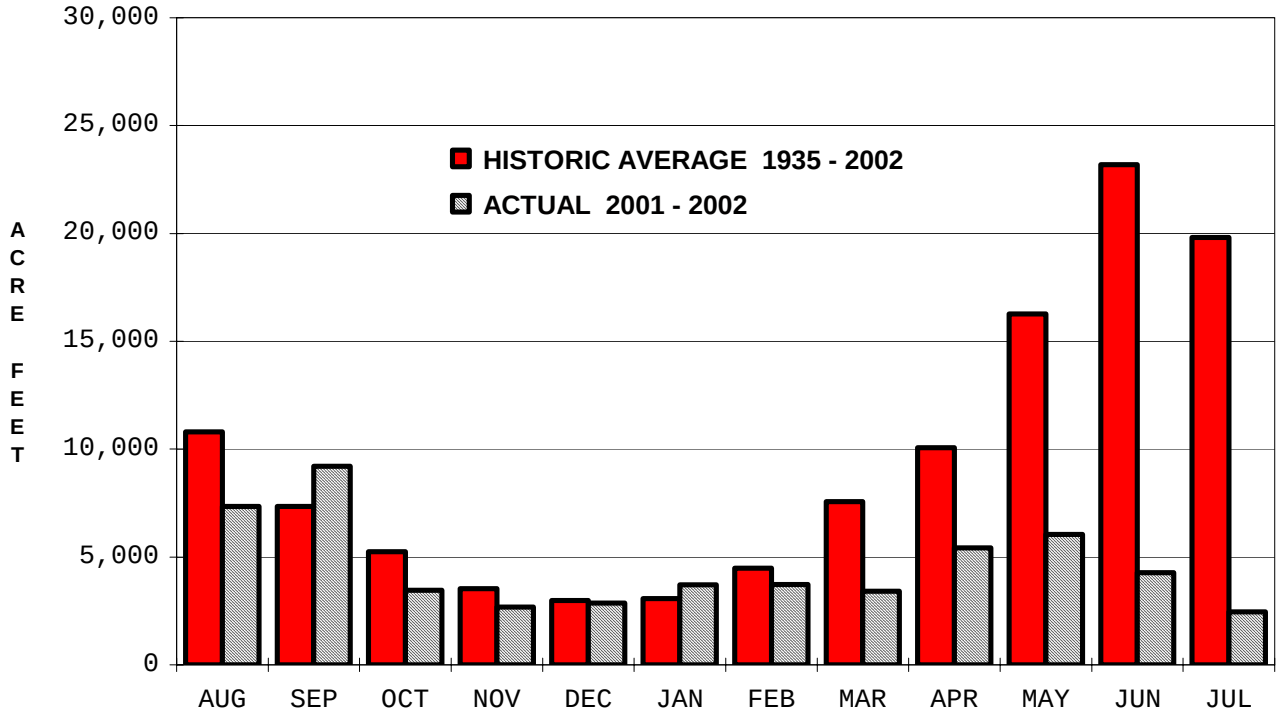



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1516.72<br>1 Aug 01** | **1515.29<br>31 Jul 02** | **1516.74<br>3-4 Aug 01** | **1515.29<br>31 Jul 02** | **1548.27<br>13 Aug 93** | **1509.62<br>27 May 92** |

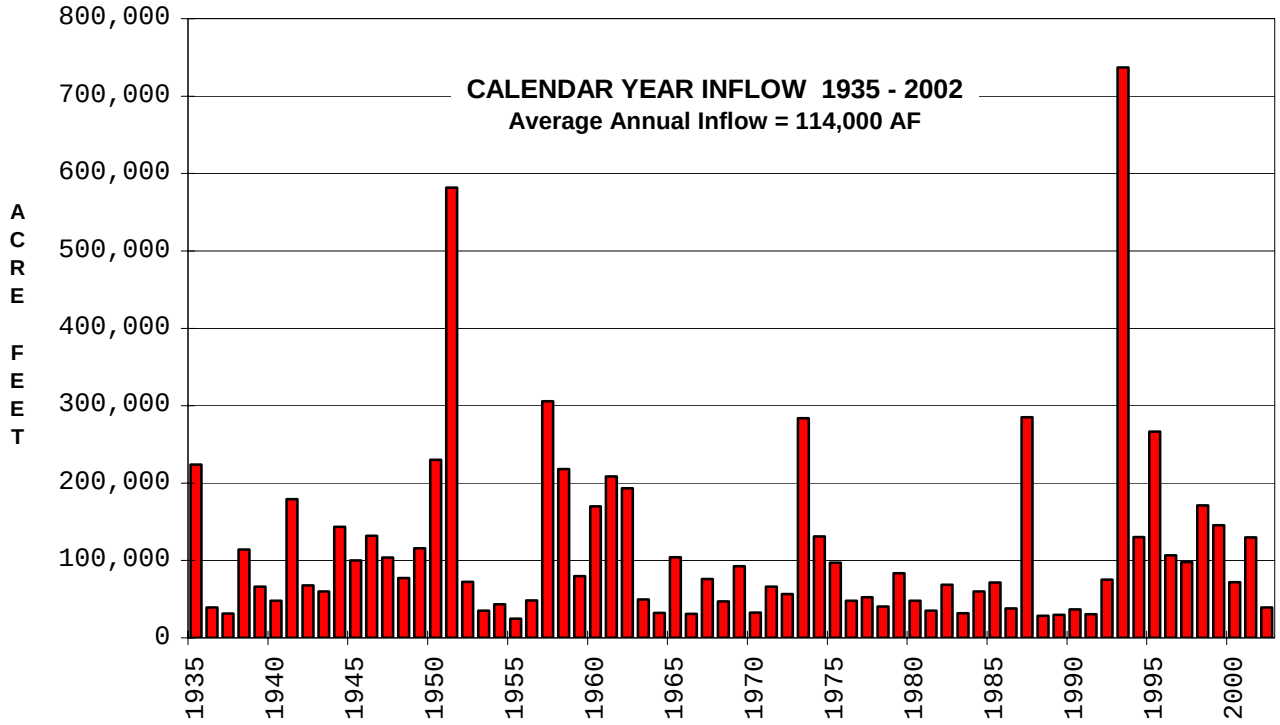
| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **970<br>18 Sep 01** | **54,587 ( 48%)<br>114,825 AF previous period** | **250<br>14-17 Oct 01** | **5, Most of the time, Oct 01 to Mar 02** |

All outflows are to the river. Minimum required release of 5-15 cfs varies seasonally

## WILSON LAKE MONTHLY INFLOW




## WILSON LAKE ANNUAL INFLOW



# APPENDIX B
# BUREAU OF RECLAMATION PROJECTS

BONNY RESERVOIR

CEDAR BLUFF RESERVOIR

ENDERS RESERVOIR

HARRY STRUNK LAKE
(Medicine Creek Dam)

HUGH BUTLER LAKE
(Red Willow Dam)

KEITH SEBELIUS LAKE
(Norton Dam)

KIRWIN RESERVOIR

LOVEWELL RESERVOIR

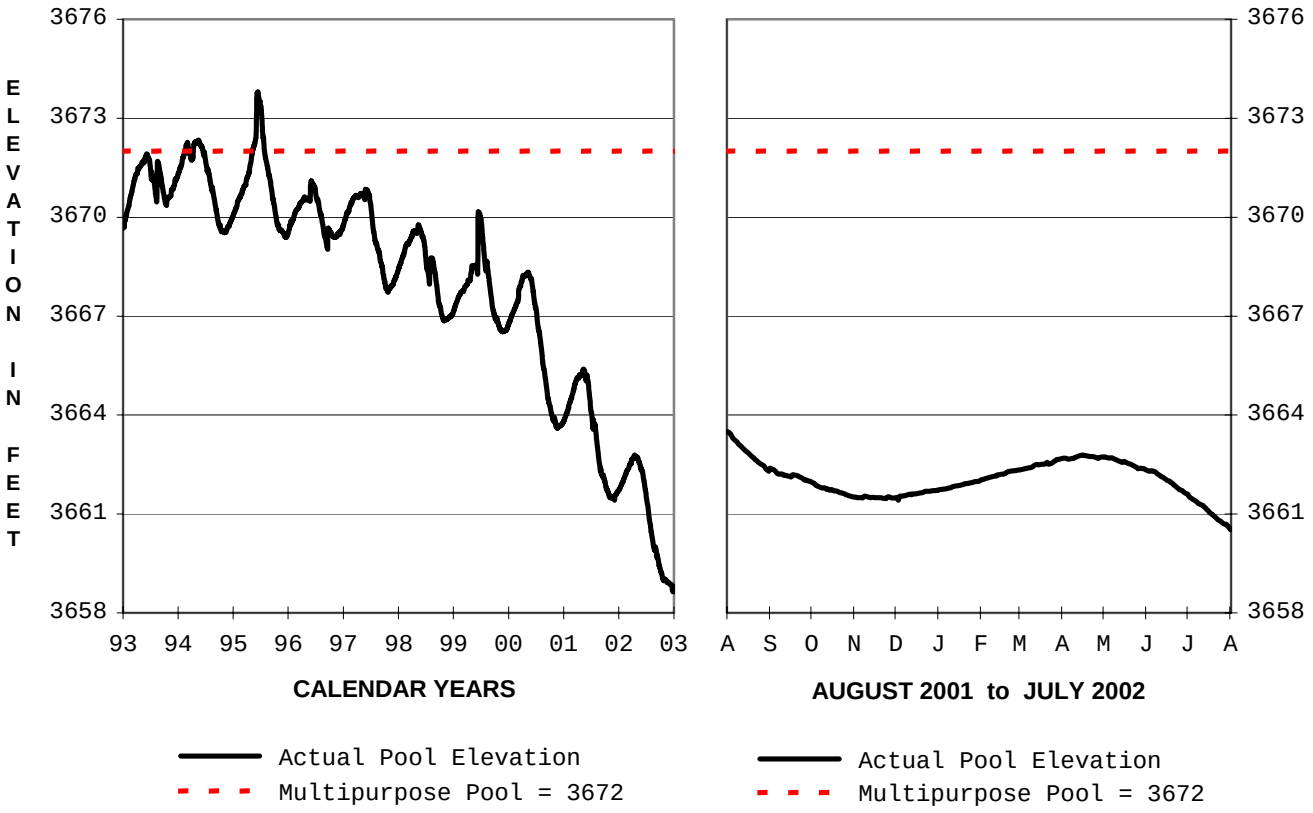
SWANSON LAKE
(Trenton Dam)

WACONDA LAKE
(Glen Elder Dam)

WEBSTER RESERVOIR

# BONNY RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



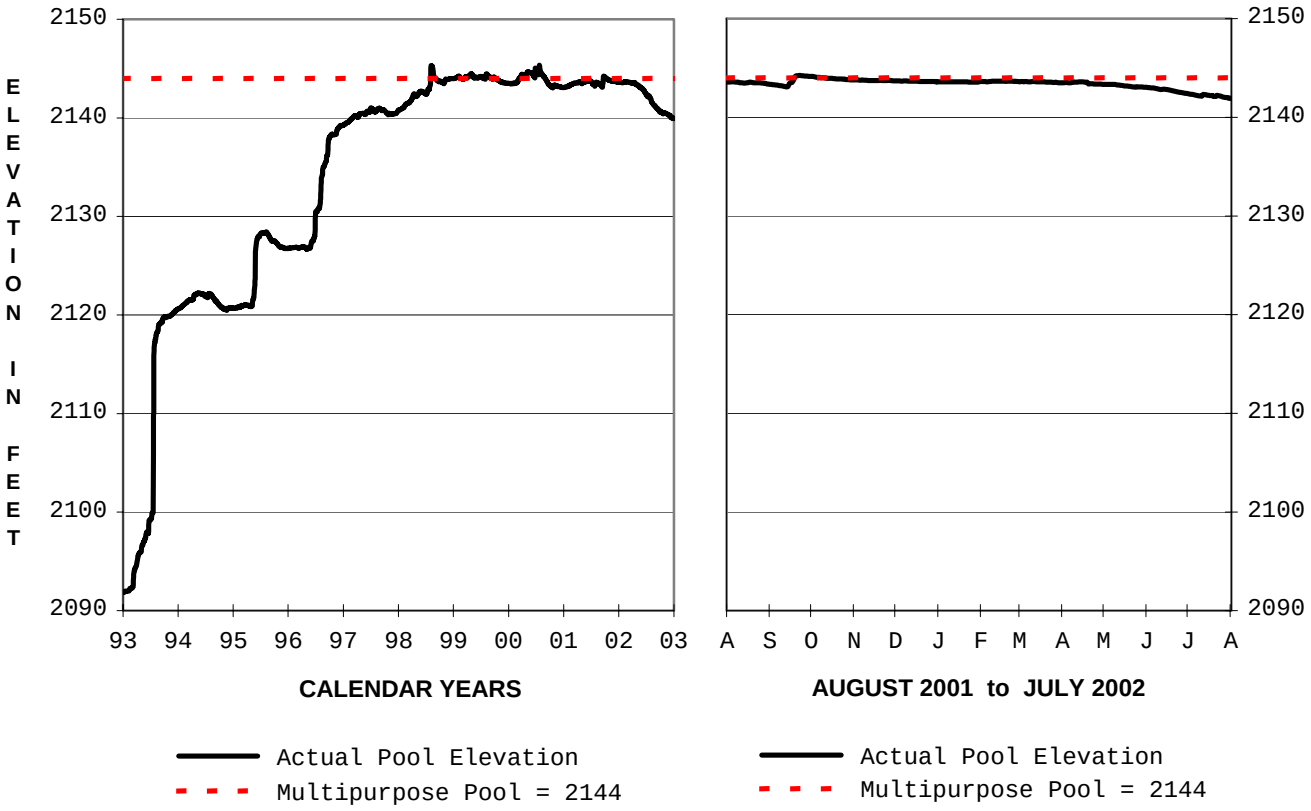

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **3663.50<br>1 Aug 01** | **3660.59<br>31 Jul 02** | **3663.50<br>1 Aug 01** | **3660.59<br>31 Jul 02** | **3678.10<br>17 May 57** | **3660.59<br>31 Jul 02** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **80<br>17 Sep 01** | **8,049 ( 48%)<br>9,046 AF previous period** | **7<br>Most of the year** | **6<br>20 Mar to 31 Jul 02** |

Max daily outflow is river release only. Max release with canal was 17 cfs on 1-20 Aug 01. Min release is 5 cfs.

# CEDAR BLUFF RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**

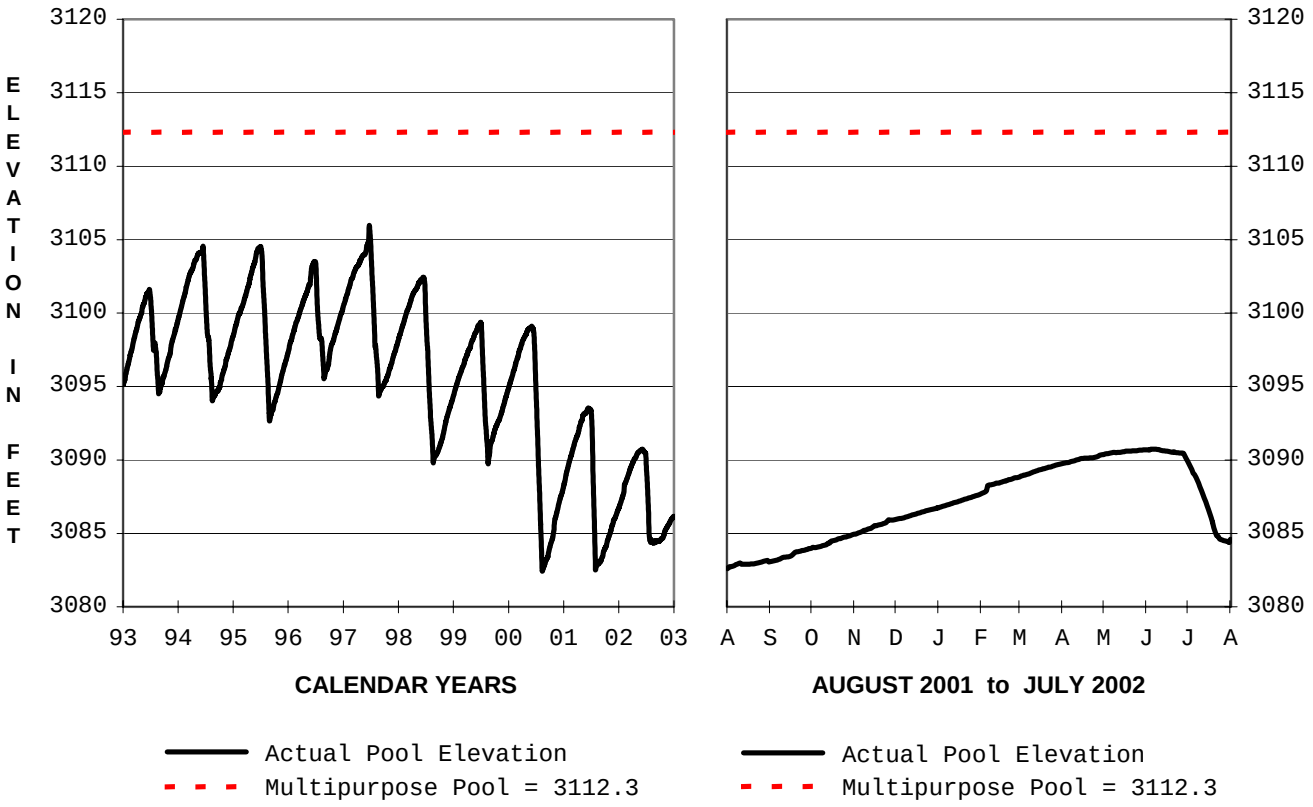



| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2143.58<br>1 Aug 01** | **2141.96<br>31 Jul 02** | **2144.24<br>22-23 Sep 01** | **2141.96<br>31 Jul 02** | **2154.90, 2 Jul 51<br>4-5 Jul 57** | **2091.78<br>9-19 Nov 92** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **1,300<br>19 Sep 01** | **21,037 ( 154%)<br>22,202 AF previous period** | **50<br>26 Jul 02** | **0<br>Most of the year** |
| Max daily outflow is river release only. No required min release. No canal releases. Minor releases to fish hatchery. | | | |

# ENDERS RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



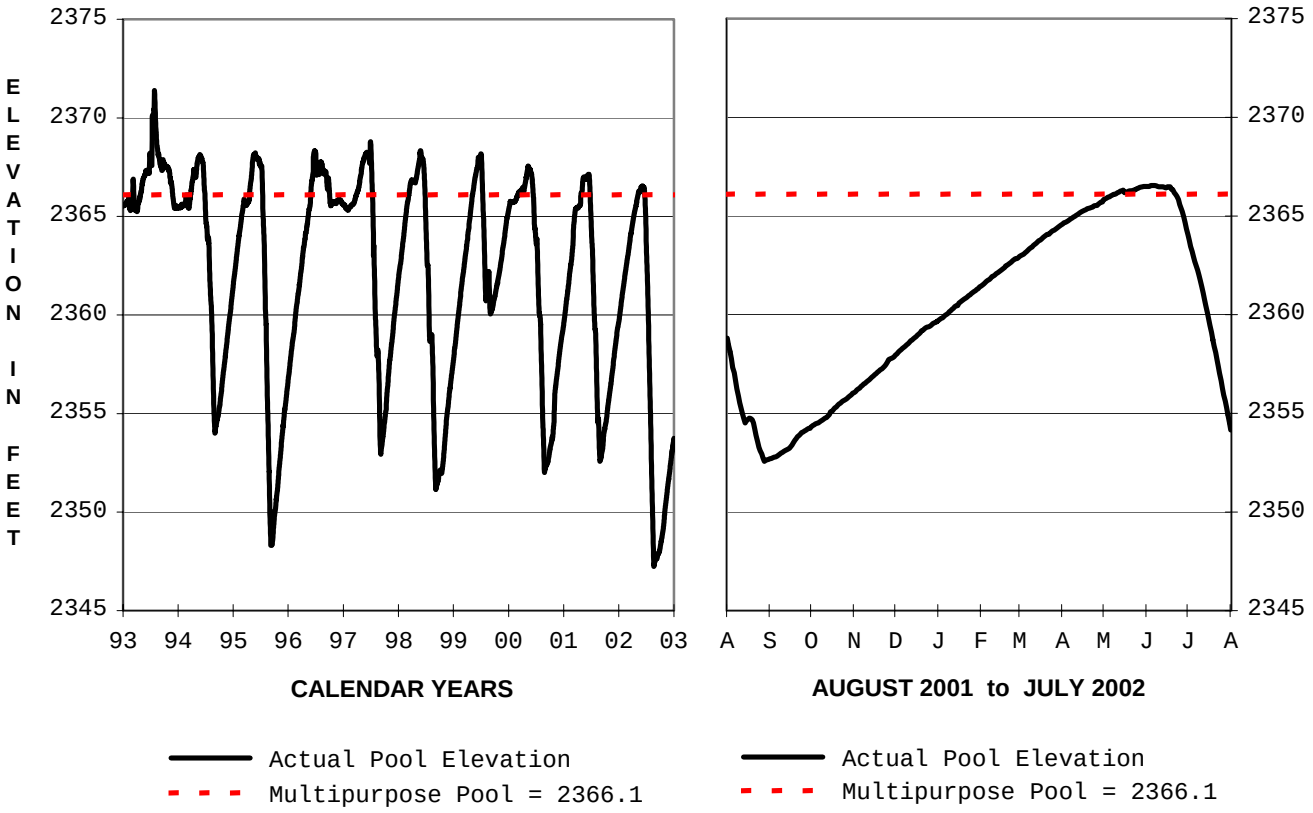

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **3082.60<br>1 Aug 01** | **3084.39<br>31 Jul 02** | **3090.74<br>5-6 Jun 02** | **3082.60<br>1 Aug 01** | **3118.20<br>25 Mar 60** | **3080.67<br>28 Aug 78** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **50<br>13 Oct 01** | **8,877 ( 41%)<br>12,053 AF previous period** | **125<br>21 Jul 02** | **1, Most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release.

# HARRY STRUNK LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



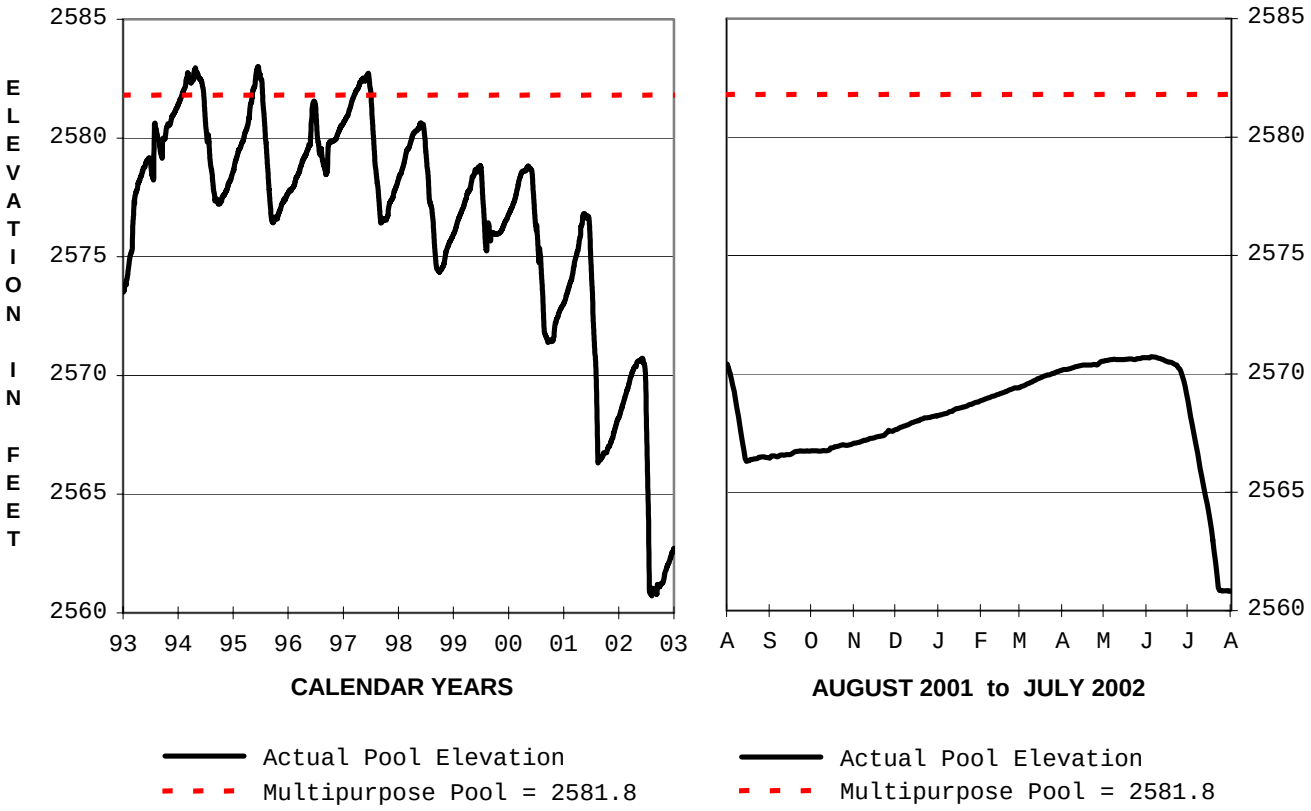

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2358.81<br>1 Aug 01** | **2354.53<br>31 Jul 02** | **2366.55<br>7 Jun 02** | **2352.57<br>28 Aug 01** | **2374.10<br>23 Mar 60** | **2340.42<br>8 Sep 78** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **200<br>15 Aug 01** | **32,081 ( 81%)<br>37,868 AF previous period** | **314<br>28 Jun 02** | **1, Most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release.

# HUGH BUTLER LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



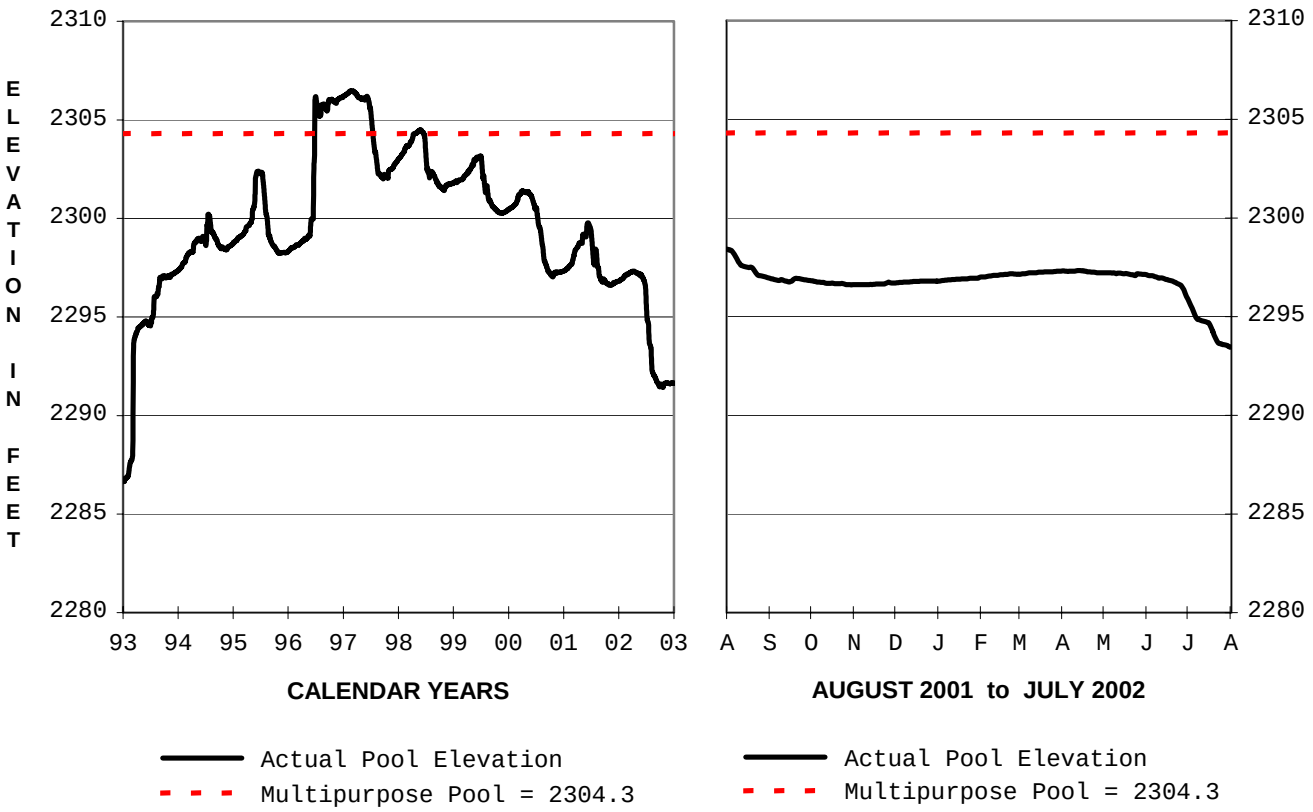

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2570.42<br>1 Aug 01** | **2560.82<br>31 Jul 02** | **2570.73<br>4-5 Jun 02** | **2560.82<br>31 Jul 02** | **2584.11<br>16 Jul 67** | **2560.82<br>31 Jul 02** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **75<br>15 Oct 01** | **11,475 ( 62%)<br>13,349 AF previous period** | **235<br>23 Jul 02** | **4, Most of the year when not irrigating** |

Max daily outflow occurred as part of normal irrigation releases. All releases to the river. No required min release.

# KEITH SEBELIUS LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD E XPANDED FOR READING EASE.**



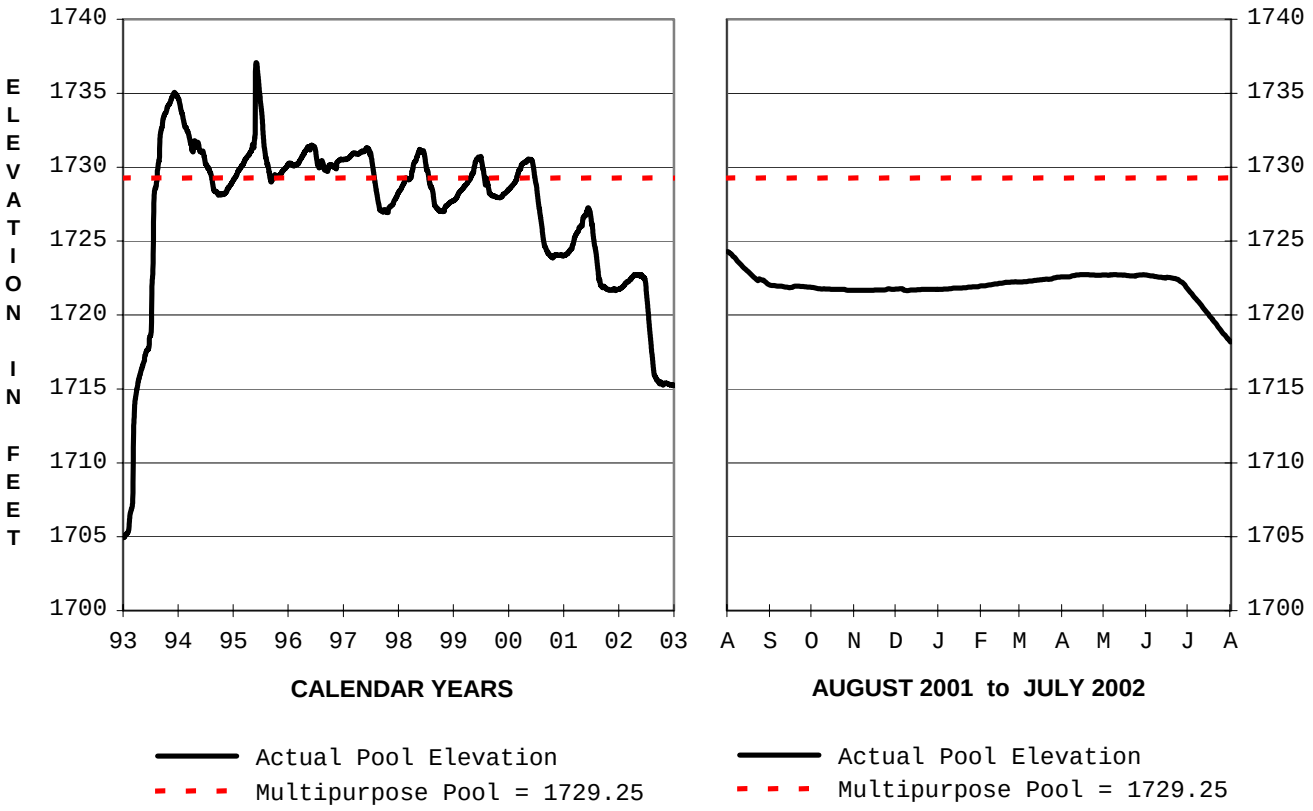

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2298.42<br>1 Aug 01** | **2293.47<br>31 Jul 02** | **2298.42<br>1 Aug 01** | **2293.47<br>31 Jul 02** | **2306.47<br>15 Feb to 4 Mar 97** | **2275.82<br>1 Feb 82** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **50, 19 Sep 01<br>26 Nov 01, 23 Jul 02** | **6,132 ( 89%)<br>10,326 AF previous period** | **100<br>4-7 Jul 02** | **1, Most of the year when not irrigating** |

City release 0-2 cfs. Max daily release with municipal release was 102 cfs on 4-5 Jul 02. No required min release. Historic Minimum Pool Elevation of 2275.82 occurred on many days 28-29 Nov 81 and 20 Jan to 1 Feb 82.

# KIRWIN RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



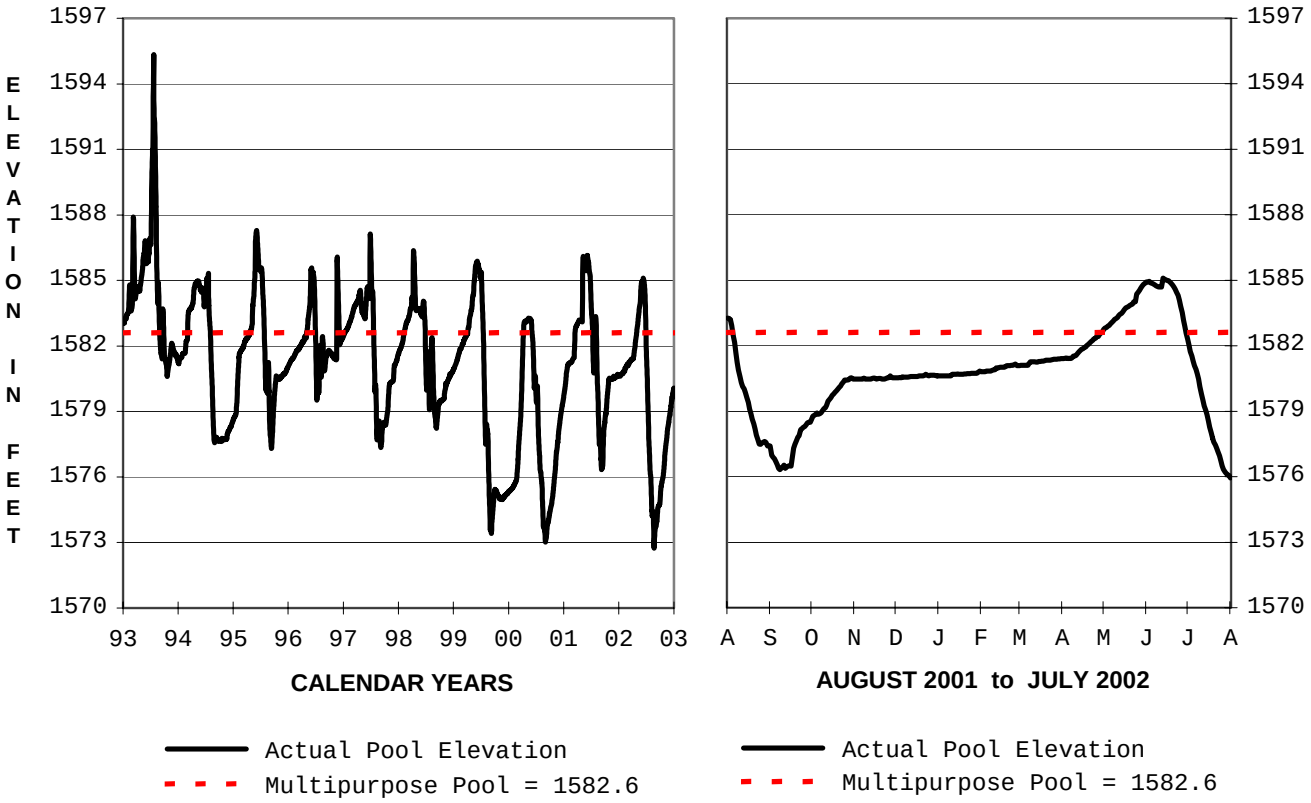

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1724.30<br>1 Aug 01** | **1718.30<br>31 Jul 02** | **1724.30<br>1 Aug 01** | **1718.30<br>31 Jul 02** | **1737.07<br>2 Jun 95** | **1695.45<br>11 Feb 81** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of norm) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **350<br>24 Aug 01** | **13,950 ( 66%)<br>25,156 AF previous period** | **0<br>Entire year** | **0, Entire year, no minimum required release** |

Maximum daily outflow is river release only. All releases to canal. Maximum canal release 191 cfs on 23-24 Jul 02.

# LOVEWELL RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW**
**WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



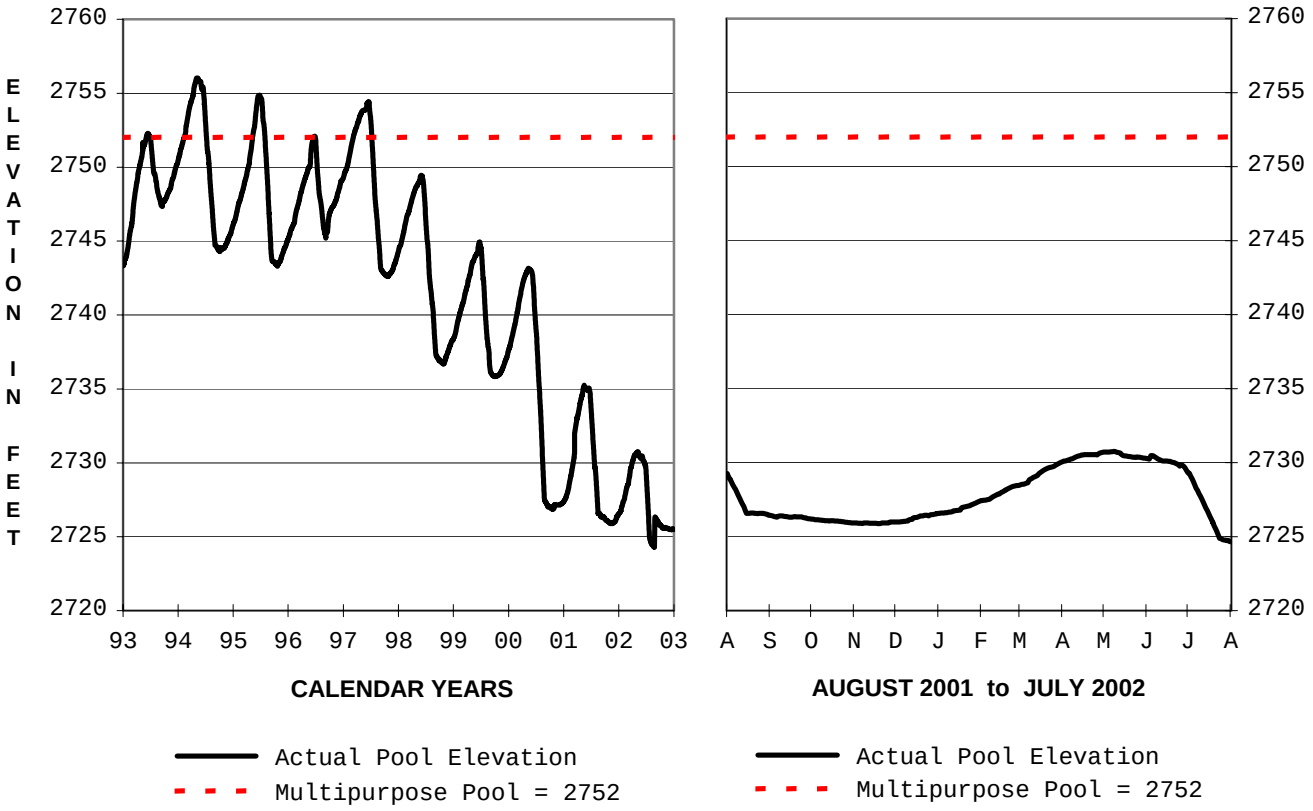

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1583.27<br>1 Aug 01** | **1576.04<br>31 Jul 02** | **1585.10<br>13 Jun 02** | **1576.04<br>31 Jul 02** | **1595.34<br>22 Jul 93** | **1570.20<br>22 Aug 91** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **270<br>25 May 02** | **13,224 ( 46%)<br>35,200 AF previous period** | **0, All year<br>All releases to canal** | **0<br>All year** |

Period Total Inflow is from White Rock Creek only. Additional water is diverted from Republican River to Lovewell. Maximum daily outflow is river release only. Maximum canal release 691 cfs on 7 Aug 01. No required min release.

# SWANSON LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



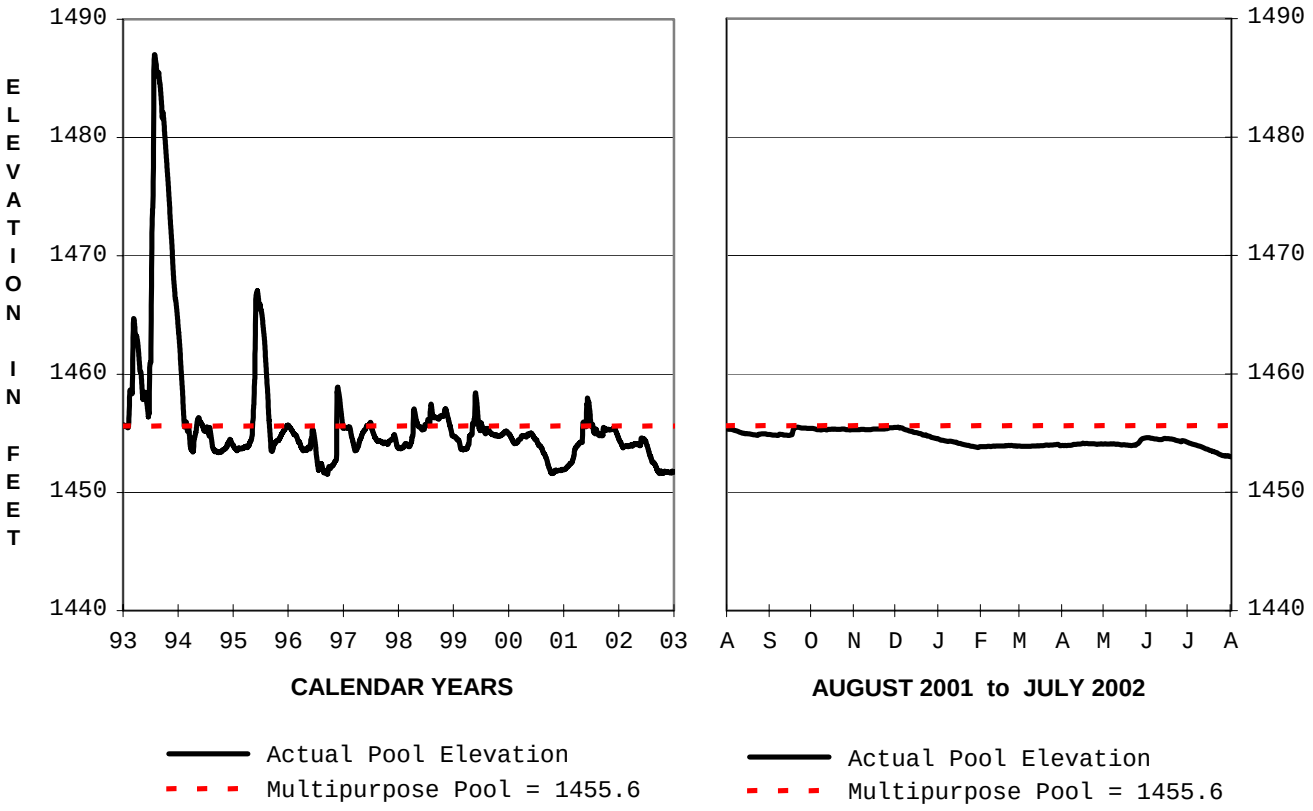

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **2729.26<br>1 Aug 01** | **2724.69<br>31 Jul 02** | **2730.75<br>8 May 02** | **2724.69<br>31 Jul 02** | **2757.40<br>3-4 Aug 62** | **2724.69<br>31 Jul 02** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **90<br>9 Mar 02** | **15,670 ( 25%)<br>24,910 AF previous period** | **1<br>Most of the year** | **1, Most of the year when not irrigating** |

Max daily outflow is river release only. Max release with canal was 222 cfs on 14 Aug 01. No required min release.

# WACONDA LAKE
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**



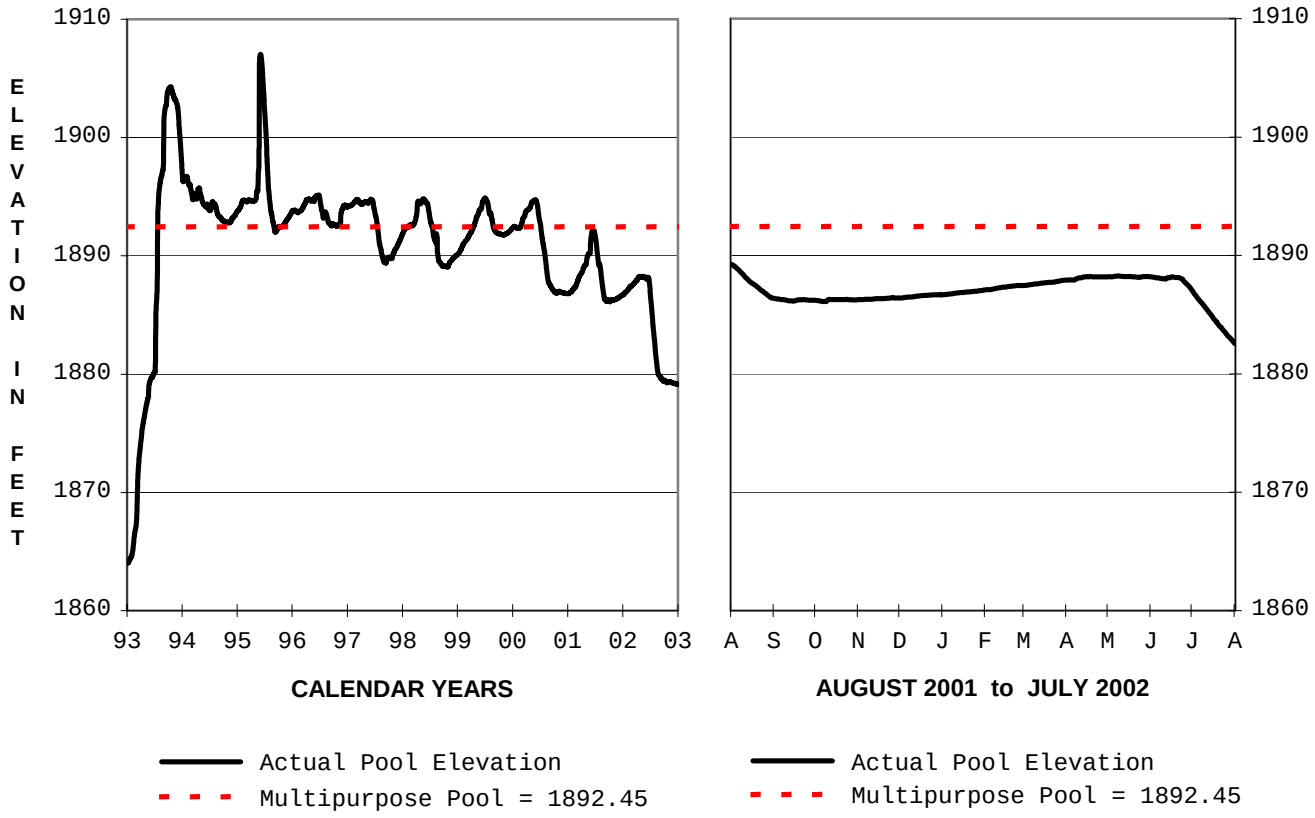

| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1455.33<br>1 Aug 01** | **1453.04<br>31 Jul 02** | **1455.49<br>21 Sep, 3 Dec 01** | **1453.03<br>31 Jul 02** | **1487.02<br>29 Jul 93** | **1448.90<br>6-7 Dec 84** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **2,700<br>18 Sep 01** | **79,135 ( 58%)<br>150,207 AF previous period** | **250<br>6 Dec 01 to 28 Jan 02** | **0, 27-29 Mar 02<br>For maintenance** |

Maximum daily outflow is river release only. Also have 0-2 cfs city release from pool. Normal min release is 24 cfs.

# WEBSTER RESERVOIR
# 2001 - 2002 REGULATION

**A 10-YEAR POOL ELEVATION HYDROGRAPH IS SHOWN BELOW WITH THE CURRENT REPORTING PERIOD EXPANDED FOR READING EASE.**




| Pool Elevation, ft. msl. | | | | | |
|---|---|---|---|---|---|
| Starting Period | Ending Period | Period Maximum | Period Minimum | Historic Maximum | Historic Minimum |
| **1889.25<br>1 Aug 01** | **1882.72<br>31 Jul 02** | **1889.25<br>1 Aug 01** | **1882.72<br>31 Jul 02** | **1907.04<br>5 Jun 95** | **1857.35<br>22-29 Oct 71** |

| Report Period Inflow and Outflow | | | |
|---|---|---|---|
| Maximum Daily Inflow Day Second Feet | Period Total Inflow Acre Feet (% of normal) | Maximum Daily Outflow Day Second Feet | Minimum Daily Outflow Day Second Feet |
| **230<br>10 Oct 01** | **14,798 ( 87%)<br>25,582 AF previous period** | **210<br>2-5 Jul 02** | **0, Most of the year when not irrigating** |

All releases to river. Max daily outflow occurred as part of normal irrigation releases. No required minimum release.